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BY

JOSEPH RITSON

"Pioneers, O Pioneers!"
Walt Whitman

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INTRODUCTION

FEW realise the extent to which the various occupations of humanity have been anticipated in the insect world. In agriculture, in manufactures, in industry, in social organisation, in sanitation, innumerable members of the insect world have been busy for hundreds of thousands of years.

This is so even in regard to the most recent and astounding discoveries, such as the telephone, the aeroplane, and wireless. The spider of our gardens and hedgerows has long used the telephone. Every year tiny spiders mount into the air without wings, in search of " fresh woods and pastures new " ; while Fabre, after prolonged experiments extending over several years, came to the conclusion that insects like the Peacock Butterfly were in possession of methods of communication of which human beings had no knowledge.

The writer does not profess to have touched more than the fringe of a vast and fascinating

subject, having in the main limited himself to a single example from multitudes, and by preference such as may be found in this country.

The book should furnish abundant material for addresses to the young, largely as yet unused by preachers and speakers. For years the author had great difficulty in addressing children, but after taking up entomological subjects, it became easy not only to find suitable themes but to hold the attention of the young year after year. The volume may also serve to introduce the young to a little-known but entrancing subject of study, the value of which may be inferred from the last letter of Captain Scott, at the South Pole, to his wife, expressing his wishes as to the education of their boy. "Make him interested in natural history if you can. It is better than games."

Both seniors and juniors will prefer to discover the moral teaching of the subject for themselves, and only once or twice has the writer yielded to the temptation to "point the moral and adorn the tale."

IN AGRICULTURE

THE TILLER OF THE SOIL
THE DAIRY FARMER
THE GRAIN GROWER
THE MUSHROOM GROWER

CHAPTER I

THE TILLER OF THE SOIL

Of all our industries agriculture is the oldest and most important. Without it life could not continue. Its most elementary processes were anticipated by insects ages ago. Ants have had a great share in the preparation of the soil; and this is the first requisite in agriculture. In some parts of the world a mere scratch of the surface of the land is all that is needed; but over a large part of the world much time and toil must be given to digging, ploughing, fertilising the soil.

This work was undertaken by ants long before man came upon the scene. Traces of these tiny workers may be found as far back as the Carboniferous Age. The Termites, usually called White Ants, although they are not ants in reality, go back to the Tertiary Age. By their mines and galleries and earth mounds, these tillers of the soil accomplished an immense work in the process of the suns.

Try and imaginatively reproduce that work. It seems a small thing for a tiny ant to bring up to the surface a grain of soil; but when countless millions are doing that, age after age, it means a great deal for the breaking up of the soil, its exposure to the influence of wind and rain and sun and frost.

A host of ants, like our common Yellow Ant (*Lasius flavus*), with which Lord Avebury made most of his interesting experiments, have been occupied in this essential work long long before man began to work with plough and harrow and spade.

This book deals only with insects, or an interesting account might have been given of the work of the earth-worm, which is our most important tiller of the soil, though not our oldest. Over fifty thousand of these are still occupied in an acre of garden, raising the surface of the soil some three inches every fifteen years. But it was the ant that prepared the way for this lowly plough.

Then in draining and lightening the soil ants have played an important part. If you examine the earth beneath a Yellow Ant's nest, or the flat shallow stone which usually covers that of the

Black Ant (*Lasius niger*) or the Red Ant (*Myrmica rubra*), you will find an elaborate system of galleries, tunnels, and chambers.

The Termites of tropical lands, as will be described in a subsequent chapter, carry this out on a most extensive scale, coating their tunnels with a kind of cement, which renders them more stable. The Saüba Ant, of which an account will also be found later, sometimes builds mounds thirty or forty feet long, and ten or fifteen feet broad. These heaps of sand and earth will some day play an important part in making the soil more amenable to the action of the plough, not unlike the fertile "Meadows" formed by the beaver.

Then there is an ant in South America known as the Azteca, which carries soil up into a tree, with which to form a hanging garden. The Hanging Gardens of Babylon were among the seven wonders of the ancient world. It is not impossible that the idea may have first come from the Azteca Ant; or it may have been the result of the genius of the Babylonian landscape gardeners. The Azteca carries particles of soil into trees, and there forms rounded hanging gardens. It is said to sow the seeds of special

plants not growing anywhere else. If that be so, it must be regarded as the most advanced of all our agricultural ants.

Ants, then, were the first tillers of the soil. They began their work in the dim dawn of the world's story, and have carried it on age after age to the present day.

CHAPTER II

THE DAIRY FARMER

ANTS actually keep cows and milk them, breed and rear cattle, and run dairy farms, sometimes fencing them in to keep their stock from straying. The cows are aphides, or green-flies. Plenty of observers have witnessed the milking process. I well remember the first time I had this experience. Though I had read of it, I had never witnessed the astonishing sight till one day a clump of tansy attracted my attention: first because it was infested with green-flies; and then because it was frequented by the common Garden Ant (*Lasius niger*). Curiosity was awakened.

Could there be any connection between the two things? Placing my pocket lens over an ant I saw it approach a green-fly, and with its antenna titillate the hair that grows on the fly's back. A tiny drop of liquid was exuded, and gobbled up by the ant. The process was repeated with fly after fly.

The liquid in question is a kind of honey-dew of which the ants are extremely fond. The green-fly elaborates the honey-dew as a by-product, in the extraction of nitrogen from the sap of the plant on which it happens to feed. This by-product must be got rid of, and if the ant did not utilise it, then it would be blown away. An enormous quantity of plant-juice must be absorbed for a very minute portion of nitrogen. Between ant and aphis there seems to be a perfect understanding. The one is quite willing that the other should relieve it of that which is counted of no value.

To secure a regular supply of honey-dew the ants sometimes keep their cows on dairy farms. I suspect that my clump of tansy was a regular ants' dairy farm. At first I wondered how it was that, though the tansy was cleared away every autumn, and the ground dug up, the green-fly made its appearance again next year. I could understand how the aphis might deposit its eggs in the autumn on the bud of a rose, where it would remain all through the winter and hatch out in spring; but no buds remained over winter in the case of the tansy.

Winged aphides might deposit a certain number

of eggs on the tansy; but the probability is that the main swarm was due to the fact that in autumn the ants had carried into their nest, across the path, the eggs of the green-fly in autumn, preserved them carefully through the winter, and then stocked their tansy farm with them the following spring. It is alleged by an eminent authority that some ants "empark their dairy stock on the ground by throwing up around their field of pasture a kind of fence. This is the grazing-field to which the ants repair for the purpose of milking their herds. I am frequently present in the evening at these Dutch-like scenes."

But this is just another illustration of the law of reciprocity that runs through all nature. Ants and aphides are mutually useful. In the ants' farm the aphides are ensured suitable and abundant food, and protected from innumerable enemies by the formidable mandibles and formic acid of their patrons. On the other hand, the ants secure a regular supply of the coveted honey for themselves and their young.

This principle of reciprocity is illustrated by the tree which receives from the earth the elements it requires for its growth and develop-

ment; and in return gives back leaves for the enrichment of the soil. The leaves of the tree receive oxygen from the atmosphere and give back carbonic acid. So in the vegetable as well as in the animal kingdom the law of giving and receiving everywhere obtains.

CHAPTER III

THE GRAIN GROWER

DOES the ant store grain in summer for winter use, as Solomon declared? For long the statement was ridiculed. Nobody had ever known such a thing. So said all the authorities from Latrielle to Kirby; and Mark Twain made merry, in his own way, at Solomon's expense. But in later years Solomon has been triumphantly vindicated. Now we know that in every continent harvesting ants are to be found. As Edward Step observes, "Solomon must have been either an acute observer of ants in his own part of the world, or have got his information from someone who had paid close attention to them."[1] There are some, both European and British, ants that store the seeds of grasses, sometimes in quite considerable quantities.

One observer has recorded the results of his examination of the habits of a Black Ant (*Messor*

[1] "Go to the Ant."

barbarus) on the Riviera. He found two long lines of ants proceeding to and from the nest, one line laden with seeds, the other without. An ant would sometimes climb the stem of a Shepherd's Purse, cut off a seed and drop it to the ground, where it was picked up by other workers. A curious thing was that he sometimes found ants, apparently less experienced than others, carrying a twig or a fragment of leaf into the nest. These were afterwards again brought to the surface and cast upon the midden.

A still more remarkable thing is that the ants have some method of preventing the seeds from sprouting. How, is a mystery, especially as the vitality of the seeds is not impaired.

Equally remarkable is the fact that they would sometimes allow a portion of seeds to germinate, thus converting the starch into sugar. They stopped the process, however, at the point where the growth of the seedling would have used up the sugar. Biting off the radicle and the sprouting germ, the ants killed the young plants and then dried their "malts" in the sun.

All this, however, pales into comparative insignificance beside the achievements of the

Agricultural Ant of Texas, as described by Dr H. C. M'Cook, of Philadelphia. This ant is half an inch long, with a smaller form of worker little more than a quarter of an inch in length. The nest is marked by a central mound of earth, surrounding which is a clearing where the ants have cut down the grass. This space is from seven to twelve feet in diameter. Hard level roads radiate from here (sometimes three or four or even seven) into the dense grass, from which the stores of grain are obtained.

From the central cleared space openings communicate with underground galleries. The seeds of ant-rice, needle-grass, buffalo-grass, are carried into the nest, cleaned from husks and dirt, and stored in special chambers. The refuse is brought out and piled in little heaps close to the edge of the cleared space. During winter, when the ants remain underground, the cleared space becomes overgrown with weeds, but in spring these are all cut away.

After heavy rains the ants, knowing the grain owing to dampness would sprout, bring it to the surface to dry, afterwards re-storing it in the grain-chambers.

Apparently, therefore, the reports sometimes

made that these ants themselves sow the grain is incorrect ; they reap the grain and store it for future use.

Harvesting ants of varied species are also found in the United States, Australia, and India.

CHAPTER IV

THE MUSHROOM GROWER

To grow mushrooms, methodically preparing the beds necessary for the purpose, is surely one of the closest approaches to reason to be found in the insect world. This is done by the Saüba Ant, which bears also the names of Leaf-cutting Ant and Parasol Ant. A native of tropical American, Indian, and Australian forests, it is found in enormous numbers, as travellers know to their cost, who, pushing their way through dense growths of forest, bring showers of Saübas down upon themselves.

The ravages of these ants in coffee and cotton plantations are disastrous; the trees are completely stripped of leaves and ruined. There are two classes of workers, major and minor. The former are three-quarters of an inch in length, the latter only one-sixth of an inch. The major ants, occupying themselves chiefly with the mushroom culture, seldom appear outside the nest.

The minor workers repair in vast numbers to the forest in quest of leaves. Climbing a tree, the ant will make a nearly semi-circular cut in a leaf with its scissor-like jaws, then, grasping the edge, will jerk away the severed piece. This may be at once conveyed to the nest, or dropped to the ground, where other workers will pick it up, and join the huge procession of parasol-bearers home; for the leaf hoisted over the back assumes that appearance and nearly conceals the ant. These journeys to and from the nest, continued incessantly for ages, have worn a bare, smooth pathway, as if made by a cartwheel.

The first assumption of the traveller was that these leaves were used directly for food; then that they were employed as manure. But careful examination of the numerous underground chambers, as large as a man's head, connected together by tunnelled passages, proved the incorrectness of both the earlier assumptions, and showed that the leaves were employed solely for the production of a species of fungus, or mushroom, used in feeding the young.

The leaves on arrival at the nest are at once cut up into small portions, mere shreds in fact, by the major workers. Each shred is cleaned

by licking it with the tongue, then rolled into a pellet and thrown upon the heap. A new bed is inoculated with a piece of fungus brought from an old bed. The leaves must be dry but not too dry. If wet, they will be left outside to dry; if very dry, they will be allowed to remain outside all night to become a little moist. The growth of the fungus is entirely under control; an even temperature is maintained, and only one kind of fungus allowed to grow. The fungus is a "felted sheet of minute threads, upon which are produced almost microscopical corpuscles," sometimes in clusters.

A young mother of a new family, of one species at least of mushroom growers, on leaving the old home will tuck away in a little open pocket, that ants have under the mouth, a portion of her last meal. This is added to the new fungus bed, made in this case by crushing some of her own eggs. This may very well be, since the starting of a new colony by the young "queen," of any species, is a matter about which there is some dispute.

But we need not go to tropical lands to find mushroom growers. The Jet Ant of English woods, which builds its nests in decaying trees,

makes a compound of triturated wood fibre, mixed with earth and saliva, throughout which run the threads of a fungus, upon whose fruiting portions the larvæ are fed.

The chambers and galleries constructed by the Saüba Ant are very extensive, so that they are miners of no common order, the nests having ramifications reaching from thirty to seventy yards from the entrance of the nest. The physical strength of these ants is extraordinary, as evidenced not only by their vast excavations, but by the loads they are able to carry, the leaf often being from two or three to ten times their own weight. It is now known that there are about a hundred species of ants which grow fungi for food.

IN MANUFACTURES

THE SPINNER
THE WEAVER
THE SILK-MAKER
THE TENT-MAKER
THE PAPER-MAKER
THE TAILOR

CHAPTER V

THE SPINNER

ALL over the land less than a hundred years ago women might have been seen in their homes busy with the spinning wheel. Out of wool they were making yarn with which to knit stockings. For untold ages the spindle and the distaff was the only mechanism for making thread out of various fibrous substances. Now all this is done by machinery of a more or less complicated kind. Yet long before the art of spinning was discovered, the caterpillar led the way as the pioneer in this useful device.

How do caterpillars spin? Very much as we do. With us from a heap of wool or cotton the thread or yarn is spun of such thickness as may be required. But the caterpillar elaborates within itself, in two long intestine-like bags, the raw material it requires. These long, slender, floating vessels contain a kind of liquid gum, out of which the thread is to be spun.

A dissected caterpillar is found to contain something very like a fountain pen, with an arrangement at the mouth closely resembling a nib. This forms the spinneret, towards which the tubes from the silk bags converge. It has been described, not inaptly, as being like a pair of distaffs for spinning the gum into a silken thread. First, a drop of gum is placed on the object from which a thread is to be suspended. The caterpillar draws back its head, and the still flowing gum is drawn out and lengthened into a thread which, under the action of the atmosphere becoming dry, acquires consistency and strength.

It is all very clever, and yet the caterpillar is said to have no brain. The nerves running along the body unite in little knots, called ganglions. But has any man been able to determine precisely the functions and powers of these ganglions, or clearing-stations? That amazingly wise and clever creature, the ant, has only a nerve-ganglion for a brain; and yet that brain, according to Darwin, is the most wonderful atom in the world. Is, then, the ganglion of the caterpillar to be despised?

See how quickly and with what delicate

adjustment it acts. If the precise strength of thread is to be secured, the spinneret needs the most instantaneous and accurate adjustment. But never is there a miscalculation made as to the proper thickness of the thread to meet any contingency. Is a thread called for to sustain the whole weight of the caterpillar's body? With the nicest regulation the thread will be made proportionate. And yet the creature has no brain, and all these clever manipulations—if the word be allowable—demanded for various purposes, must be made without hands!

It will be observed that the silk is spun from a gathered store. Of course the caterpillar may be said to have nothing to do with accumulating this store, any more than a human being with the secretion of bile or gall; but this may remind us that much of the greatest value to us is stored beforehand. What the caterpillar does unconsciously we must do consciously.

But how does the caterpillar know all about the spinning of silken threads? We say, by instinct, for want of a better word. It has been derived from her ancestors, which after all is possibly only another way of saying that the faculty is God-given. The bird never serves an

apprenticeship in constructing her beautiful nest. She never saw her mother make one; never received a single lesson in the art. And yet the nest will be constructed precisely as was that in which the bird was born.

Who has not noticed that when caterpillars are disturbed they will sometimes detach themselves from the leaf on which they have been feeding, and suspend themselves by a thread of silk. Later they ascend the thread like a spider. Evidently this is a provision against danger. Blown off a tree by the wind the caterpillar will let itself gently down by means of a cable of silk, spun on the instant, thus breaking its fall. How instantaneously the necessary adjustment must be made.

The approach of a bird will be escaped in the same way. There is a clever arrangement in the legs to aid in climbing, the six forelegs being furnished with a curved claw,—as may be seen by a pocket microscope—while the pro-legs are constructed on the principle of a vacuum, like a boy's leather sucker, enabling them to hold firmly to anything.

Then every boy who has kept caterpillars knows that periodically they change their skins.

At this period the creature ceases to feed and becomes quite helpless. A tiny puff of wind would blow it away. To guard against this it will moor itself with silk upon the leaf where it is feeding, immediately appetite fails. Thus it is safe till the old skin is sloughed off.

Again, spinning is often needed in the construction of the chrysalis or pupa. How astonished I was as a boy in watching the cabbage caterpillar constructing a tiny loop by which the chrysalis was to be suspended. The tail would be securely gummed to the spot where the pupa was to find its resting-place, followed by the formation of the loop. How did the insect know all these things? I could not answer the question then; nor can I answer it now.

CHAPTER VI

THE WEAVER

AMONG the spiders[1] there are not only artistic spinners but extraordinarily clever weavers. The warp and weft of their fabrics may be said to rival some of our finest manufactures. And we do not need to visit foreign countries to find wonderful samples of this. The great sheet-web spider of our hedgerows will furnish all we require. Its name is *Agelena*, and however sinister of aspect, as it sits at the door of its den watching for its prey, it has its points both in name and products. I remember in boyhood imprisoning its first cousin, the common house-spider, in a small box to which I fixed a glass top. The web was quickly spun, and I introduced flies, watching the result.

This is what has been done with *Agelena* by Cecil Warburton, and the results of his observa-

[1] Having eight legs, the spider is not an insect, but may be included in our insect world in this connection.

tions are recorded in his book, "Spiders," the little Cambridge Manual of Science. The captive spider soon became busy attaching lines to the sides of the box, some height above the floor, and gradually the sheet-web and its terminal tube revealed itself. All day long the process went on till the sheet was so closely woven as to become almost opaque.

It was in the construction of the receptacle for the eggs that *Agelena* revealed her skill as a weaver. First of all a hammock-like compartment was woven from the roof of the box and above the sheet-web. This chamber, about four inches long, was constructed in the same manner as the sheet, to which it was braced by lines from various points of its under surface. This work occupied a whole day up to within half an hour of midnight. Within this compartment, close to the roof, the spider next wove a small sheet an inch long, working diligently in an inverted position. After a quarter of an hour it rested for an equal space, apparently exhausted by its prolonged efforts. An hour and three-quarters intermittent work served to complete the sheet. A marked change now became observable in the manner of working. The

animal abandoned its incessant to and fro motion, but began to jerk its body up towards the sheet, throwing silk strongly against it.

At the same time the posterior spinnerets were strongly rubbed together, and the long posterior spinnerets separated and brought together again with a scissor-like action. The result of this performance was to invest the under surface of the small sheet with a coating of flossy silk quite unlike the ordinary web in texture, the purpose of which soon became evident; for at about a quarter past two the spider began to deposit its eggs *upwards*, against this loose-textured silk, aiding the egg-mass to adhere by occasional upward jerks of the body. The egg-mass was then covered by a layer of flossy silk similar to that against which it was laid, the eggs being thus entirely enveloped in a coating of soft, loose-textured material. This was next covered in by a sheet of firm texture like that of the original web.

This was not the finish. The eggs were next enclosed in a wonderful transparent box of filmy silk, with the egg-bearing sheet for its roof, of moderate strength and opacity, and the spider having worked "the clock round," while

not labouring continuously, kept giving further touches to her work, clinging tenaciously to the spot and refusing to be frightened away from it.

Surely all this is very clever. Who taught *Agelena* the art of nest construction ? She never saw one before, and so had no model to work by.

We call it instinct, yet how marvellous it is ! Somewhere in that small body there is packed the imperious impulse which compels all these varied spinning operations in their proper succession. The ancestors of the spider have been doing that work in precisely the same way for ages. They learn nothing and forget nothing.

Hence *Agelena*, though very clever, is also very stupid. Take away her eggs immediately they are deposited, and she will continue the work precisely as if they were there. The nest will be laboriously built round the place where the eggs ought to be, and the mother will cling as desperately to the spot, when her work is completed, as if the precious eggs were there. Like a machine she has worked from some mysterious and irresistible impulse.

CHAPTER VII

THE SILK-MAKER

NEARLY all caterpillars are members of the great guild of silk-makers; but the master of the craft is the Silk-worm. It is so called, though not a worm at all. The caterpillar of the silk moth, it begins life about a quarter of an inch in length, but rapidly increases in size, till finally nearly three inches long. In colour it is a yellowish grey. The perfected insect, or imago, is about an inch in length, of a pale buff colour, with a broad pale brown bar across the upper wings. The moth produces a great many eggs of about the size of a pin's head, fastened to the surface of the leaf by a gummy substance.

For seven out of the eight weeks of its life, the silk-worm is busy elaborating the material for the manufacture of silk. This is stored in reservoirs along its side, which communicate with the usual pen-nib-like structure at the head,

from which the silk is drawn in a double stream. The creature feeds voraciously, and concentrates all its energy upon its one business.

Four times during its life the silk-worm changes its skin, owing to its rapid growth. When the skin is ready to be cast off it splits at the fore part, and the caterpillar writhes and wriggles till the old skin is thrust off backwards. Then its appetite, temporarily in abeyance, returns, and it feeds voraciously.

Funny that we do not change our skins like that! No, not like that, but we do change them and everything else. We get a new body, it is said, every seven years. Mentally, too, we undergo similar renewal. The notions of childhood do not fit our maturer years. A very great man once said: "When I was a child I thought as a child, I spake as a child, I understood as a child; but now that I have become a man I have put away childish things." Unfortunately some people never grow up but remain childish all their days.

Most interesting is the silk-worm when full grown; for it sets itself to spin a threefold cocoon. Let us watch it. Bending its head here and there, it spins a rough structure of a

kind of floss silk, to keep out the rain. I am afraid we cannot watch it in its next operation as closely as we would like; but this has been seen by clever observers. This inner chrysalis of fine silk is to be a protection against the wind. The silk-worm moves its head from side to side in such exact order that afterwards the thread can be regularly unwound. The innermost cocoon of all is spun of a stronger and more gummy silk, all the inner threads being bound one over another. A kind of tapestry in which the insect lodges, it is capable of repelling air, water, and cold. And here is undergone the last change into a moth.

All this serves to fill the mind with astonishment, and we are ready to ask a thousand and one questions, most of which the wisest cannot answer. But like so many of Nature's works, it reminds us of the mystery that is ourselves. The body, so fearfully and wonderfully made, is yet only the shell enshrining more precious things. The brain, contained in the skull, with its three thousand million cells, is a marvellous instrument, but only an instrument. Behind it is the spirit of man which operates through brain and body.

Where precisely it has its home no man can tell. How, exactly, it operates through the brain is equally a mystery. Somewhere is the innermost shrine of all, where dwells the real man, whose thoughts do wander through eternity; whose aspirations soar beyond the stars; whose loftiest capacity is for the God who made him. There in that secret chamber may be developed that before whose splendour sun and moon and stars pale their glory, in comparison with which all the wonders and beauties of Nature are dwarfed into insignificance.

And yet we must not belittle the silk-worm with this august comparison. It achieves a marvellous piece of work. In five days it spins its three wonderful chrysalides. Commercially, that in the middle is the most valuable, with its two thousand feet of silk. By the clever weaver this would be counted a mere by-product, essential to the preservation of the precious life within, and indispensable to the continuance of the race. To it the life is more than silk. But that silk has been of immense service to humanity, furnishing employment to countless multitudes of men and women, and adding incalculably to the comfort and enjoyment of the race.

Nor need we despise the by-products of humanity, even where only material in their character. It is not merely that the varied activities of mankind serve useful and beneficent purposes: feeding the hungry, clothing the naked, mastering the forces of Nature, and rendering them subservient to human need, but carried out in the true spirit ministering to the development of the highest in man. And as the life is more than meat and the body than raiment, so the spirit exceeds in value and importance the material envelope in which it is enclosed. All this is enshrined in the question of Him who spake as never man spake: "What shall it profit a man if he gain the whole world and lose his own soul?"

CHAPTER VIII

THE TENT-MAKER

THE tiny *Tincidae* was a tent-maker by profession long before the days of the Apostle Paul. It were more correct to say that the child of the *Tincidae*, that being the name of a small moth, has from time immemorial been a maker of tents. It is to be found on the leaves of the oak, the elm, the hawthorn, the pear tree, and the nettle. What is the tent like? Well, you have seen the titty that is sold for babies to suck. That is its style if not its title. The broad end is uppermost, and from the small end the tent-dweller emerges to feed, carrying his tent about with him very much as a snail carries his shell.

This little creature is a house-builder, who waits for no Government Acts, no Council decisions or schemes, no designs old or new. Directly on emerging from the shell the wee caterpillar sets about making its tent, refusing

to live, or even eat, without a covering. The *whole process of tent-making might be seen,* were you to watch the youngster on the leaf of an elm or alder or any tree with serrated leaves, such as its species affects.

The materials for the tent are found immediately at hand. Tiny Tim, as we may call him, begins by eating through the two outer membranes which compose the leaf. These enclose the pulp, some of which the little worker will devour. Next it will thrust its body into the cavity between the two membranes. If the space is found too small it will be at once enlarged, and soon a place will be made rather larger than the body of the occupant. By this time a good part of the pulp is devoured, and the membranes, or leaf-skins, being transparent, will allow every movement of the worker to be observed.

For his task Tiny Tim is provided with a plan of his tent and the tools required for its erection. With his sharp scissor-like mandibles, or jaws, he cuts out the two sides of his curious tent. Tailors and dressmakers have patterns for their work. So has Tiny Tim. Only you cannot see them. They are inside him some-

where, and were born with him, otherwise he could not begin his tent-making immediately after birth. We call this instinct, but really we know very little about it. Many of the cleverest men have been studying it for years, but much about it baffles them. Insects need to serve no apprenticeship: they are masters of their craft the first second they open their eyes.

If one of the completed tents be examined it will be seen at once that the peculiar shape of the two extremities will require different curvatures, and the business of shaping them will be as delicate as cutting a coat out of a piece of cloth. The material must be slightly convex on one side and concave on the other, and at one end twice as large as at the other. Now watch our little mechanic closely. Beginning at one end Tiny Tim will bend the material gently on each side by pressing it with his body, thrown into a curve. Really it does not cut, so much as shape, the materials; the cutting is all done at the outset on the piece.

The two edges of the future tent will now be joined securely with silk. This having been done at one side, the caterpillar will put out its head on the outside of the joining, first at one

end and then at the other, and cut away the bottom fibres joining it to the leaf till the whole side is quite separated. The other side of the structure will be dealt with in the same way, and the completed tent will be moored to the uncut part of the leaf by a cable of silk, very much as a tent is pegged down to the ground. Behold now Tiny Tim's abode, standing at an angle of forty-five degrees, broad-end up.

When, however, this dweller in a tent finds it necessary to move to "fresh woods and pastures new" on his leaf-world, he does not "fold his tent like the Arab and as silently steal away," he carries his tent up-standing with him. The tent may be anything from a quarter of an inch to an inch in length, and about the breadth of an oat straw. Its colour resembles a withered leaf, and unless you know just what you are seeking you will probably overlook it. When Tim wants to feed he emerges from the small end of his tent.

And are we not all house-building, and like this tent-maker carrying, in the form of the character we have made, our house with us wherever we go? The tent of the tent-maker is not the caterpillar itself, only its temporary

abode; but a man's character is his very self, and the only thing he can take with him when he dies. A beautiful tent-character will be a joy, an ugly one a misery, here and hereafter.

"Build thee more stately mansions, O my soul,
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea!"

CHAPTER IX

THE PAPER-MAKER

THE first paper-maker was neither an Egyptian nor a Chinaman. Long, long before either dreamed of anything of the kind the common Wasp was an adept at the business. Some eight hundred years ago men discovered how to make paper from rags; but only recently have they found out how to utilise wood-pulp for the purpose. And yet from that same wood-pulp, and under men's very eyes, the detested wasp has been making paper.

In April or May a large and beautiful wasp may be seen questing about as if in search of something. That something is a suitable site for a new city. She has slept through the long winter, and has wakened up with an imperious instinct for house-building. This particular species of wasp builds her nest underground. Not wisely but too well, I harried her nests in boyhood,—sometimes smoking them

out, at others blowing them up with gunpowder, this last a fearful joy,—frequently getting stung, but without being in the least deterred from such exciting warfare.

Having found the site for her nest, the Queen Wasp of spring will mark the spot for identification by wheeling round it in her flight several times. The site, with its setting of surrounding objects, will thus be fixed in her memory. She has already satisfied herself that this old mouse-hole or mole-run is sufficiently dry for her purpose. First of all she excavates a little chamber at the end, an inch and a half in diameter.

And now the site being ready, the next thing will be the gathering of materials. The city is to be built of paper, but no ready-made stuff will do. From the weathered surface of a wooden post or paling, preferably of oak, she will rasp off a tiny portion with her jaws or mandibles. Grinding it small she moistens it with saliva from her mouth, and thus turns it into wood-pulp. This is borne off to her hole and applied as a thin layer of wasp-paper to the top of the little chamber. By degrees a disc of paper is formed, from the centre of

which a narrow stalk is hung. Around this four cells will be built in the form of a cross, with others to the number of some twenty-four, and in each cell an egg will be laid.

To conserve the heat of her own body and as a protection against any possible damp, the wasp will place a triple covering of paper around all. Here you have the first maker of paper; and very fine paper it is. For ages this beautiful, if "nasty," insect has been pointing men the way to cheap paper. Its cleverness we call instinct, and rank it lower than reason. And yet how wonderful it is!

But let us see how the paper-making proceeds as the population increases. In a week there emerges from the first egg a legless grub or larva. This is fed by the mother with the juices of animal food, such as flies and caterpillars. When full grown, the grub spins for itself a silken cocoon, and lines the inside of the cell with the same material.

In a month from the time the egg was laid, the perfect wasp will emerge. Baby must wash herself with the brushes and bristles nature has provided for the purpose. Her toilet finished

she feels hungry and finds food ready on the top of the cells where her future sisters are still imprisoned. Then forthwith she sets about helping mother to feed the grubs. Two days later she will make her first flight, in search of food for the family and paper for the enlargement of the nest. As the number of workers increases the mother wasp leaves all outside work to them, and confines herself to depositing eggs in the rapidly growing cells by the thousand. The paper-making proceeds apace now day after day, to provide housing for a population of anything from 30,000 to 60,000.

To feed that huge population not fruit but caterpillars, aphides, and flies will be required. Think what a slaughter among these enemies of the gardener and the farmer this must mean. And yet, after saving our crops, we begrudge these toilers the luxury of a little fruit in autumn. But for the wasp, often, there would have been no fruit at all.

A paper-city! But perfectly damp proof and absolutely sanitary. Of the scavengers who allow no filth to accumulate, another article might tell; and even the city sewage,

or dunghill rather, is crammed with living wonders. But enough has been told to show who failed to patent the epoch-making discovery of paper-making in the long past ages.

CHAPTER X

THE TAILOR

THIS fashioner of garments is a Clothes-Moth; and why every man's hand, and especially every woman's, should be against it, may at first sight seem strange. It is a pretty little creature, and in some respects more gracefully adorned than any other of its tribe. Surely that delicate fringe-finish of the wings should commend itself to the female mind. And though called a clothes-moth it eats no clothes. But wait a bit. Cunningly insinuating itself into the tiniest crevices, it makes its way into drawers, wardrobes, and other places where clothes are kept. It deposits its eggs on any garments it finds there, especially woollens and furs. The eggs hatch, and from them emerge tiny grubs, or larvæ, which destroy the clothes. They even got into my herbarium, making sad havoc among my beautiful dried specimens.

Not that you will readily see them the time

they are doing their mischief. Directly they are born they set to work weaving a house in which to shelter themselves. They cannot eat otherwise; it is the law of their being, and they implicitly obey it. Quite a pretty house it often is, tastefully patterned, as if the maker had an idea of the arrangement of colours; and is made of the same material as that on which the creature feeds.

Curiously enough we are all house-building from the moment we begin to live. There is the house we call the body, the character of which is largely determined by what we are. We mould the body in beauty or ugliness, a beauty or ugliness of expression rather than of form. A handsome face is not necessarily beautiful; nor is a plain one necessarily ugly. Goodness can illumine the most ordinary features, just as evil may stamp the "mark of the beast" on those that are classically moulded.

There is, too, the house of the future which, day by day, we are building, and that will be ours when the earthly house of this tabernacle is dissolved. It may be fashioned in infinite loveliness, a house not made with hands eternal in the heavens.

But how does this tiny caterpillar weave? It has no hands; but with its mandibles, or jaws, it cuts off a hair from the cloth of the correct length for its house. Then another and another till it has accumulated quite a number. Proceeding to spin silk like a silk-worm it binds the hairs it has cut from the cloth into a fabric wonderfully tough and strong. Inside this house it lives, only putting its head out to feed, and not always then, since it can devour the floor of its dwelling.

As the tenant grows the house is enlarged by ripping it open at one side, and a fresh piece is inserted right along like a patch; but far more cleverly than any coat is patched, for the new piece is actually woven into the "house." Additional pieces will be woven on at the ends to secure the requisite length. Here, then, is a house not made with hands.

And similarly with that house unseen that we are all building. No ring of hammer or mallet or chisel can be heard as the house rises; nor can any detect the whir of a shuttle. Silently our thoughts and deeds are building our house eternal. Only pure thoughts and noble deeds can build the house beautiful.

When the grub or larva is full grown it weaves another, an inner house, more beautiful than that in which it has lived. The old house was lined with silk; this is also, but of finer quality. Here, wrapped in its silken shroud, the caterpillar lies quite still, neither eating nor working. But wonderful changes are taking place in its form and structure, and one day there emerges a moth with glorious wings, covered with the most beautiful feather-like scales of iridescent hues. These wings are delicately fringed, in which adornment it stands almost alone in all the great moth world. Its eyes are wonderful too, so that it can see danger approaching from every point. The only way to capture it is by a flashing clap of your hands when it is in flight. And then how often it escapes!

When our body dies, of disease or old age, or accident, the new house will be ready. For the good it will be more beautiful than eye hath seen, or heart conceived, endowed with wonderful powers of which we can have only the vaguest ideas. "For this corruptible must put on incorruption, and this mortal must put on immortality": "a building of God, a house not made with hands, eternal in the heavens."

IN INDUSTRY

THE MASON

THE SCIENTIFIC BUILDER

THE CARPENTER

THE WHEELWRIGHT

THE MINER

THE TUNNEL-MAKER

CHAPTER XI

THE MASON

THE masons are a fairly numerous class in the insect world. There are Mason Bees and Mason Wasps, about which Fabre wrote many interesting articles. But the White Ants beat them all in the size and importance of their erections. It is pretty generally known now that these insects are not ants at all, and that their true name is Termites. But they are everywhere popularly known as White Ants. They are social in their habits, and are divided into males, females, and workers, like the ants; but their structure is quite different.

The workers are divided into soldiers and workers proper. The soldiers are born such and their business is the defence of the community; albeit they do nothing beyond seizing an enemy with their formidable jaws and holding on like grim death. They are blind like the workers, and on the latter depends all the work of build-

ing, repairing, and extending the termitarium or hill, the care of the eggs and young, and attendance upon the royal couple, falsely called the king and queen. These last are strict prisoners, kept in an apartment by themselves.

Also, like the ants, there is once a year a nuptial flight, when the young princes and princesses leave the nest and fly abroad. They are in vast numbers and are devoured wholesale by ants, lizards, spiders, toads, and goatsuckers. They fill the air with a loud rustling noise, and, again like the Princess ants, wriggle off their wings on reaching the ground.

The first thing that strikes you about these ant-hills is their size. That such small creatures should be able to build, as of solid masonry, structures from a foot to twenty feet in height, is extraordinary. The larger ones may have occupied hundreds of years in building. The form varies, but in many cases a kind of Gothic or pyramidal style is favoured, the former having innumerable spires.

Then the material of which the buildings are composed is remarkable. They are built of earth and excrement, mixed with salivary secretions, which make the whole set hard

like cement. The work of the community is entirely carried on underground. Their tunnels extend in all directions, especially under wooden buildings, with disastrous results to the owners. The tunnels are lined with masonry, so that they are in no danger of collapsing from rain or other causes. These tunnels are essential to the Termites as a means of obtaining food. Wood and vegetable substances are devoured as food.

A wooden building may be completely riddled through and through without the owner having any suspicion of the fact till the whole thing collapses. Then it is discovered that the wood has been systematically eaten away by the unseen enemy. The building is never approached from the outside; and the ant-hill itself has no place of exit or entrance visible on the outside. It is built up entirely from within; and when, for the great nuptial flight, a way out is required, the walls are temporarily pierced for the purpose. The real entrance and exit will always be found at a distance from the nest, which is approached by underground tunnels.

The Termites differ from ants in being soft-

bodied. The Queen Termite is of enormous size, rather more than three and a half inches in length and over an inch in breadth. Her bloated appearance is due to the enormous number of eggs she contains, of which she lays many thousands per day.

The numbers of Termites are not only kept down in the way described above at the time of the annual flight, but by Driver Ants, who specially prefer them as food. So nature provides for the maintenance of a due balance.

As it is, White Ants are a great nuisance to the owners of wooden buildings. No doubt they are to be reckoned among the ploughmen and fertilisers of Nature. Their tunnels have served some such purpose as this for untold ages, and by reducing dead wood to dust they have been great fertilisers of the soil.

CHAPTER XII

THE SCIENTIFIC BUILDER

It has long been a matter of astonishment that the Honey Bee should have discovered the most scientific method of building in regard to the construction of her comb, and thus solved the most difficult problem in geometry ages before that science was known to man. The cells of the bees' comb are hexagonal in shape.

It has been pointed out that there are only three possible figures of the cells which could make them equal and similar without any useless interstices: the equilateral triangle, the square, and the regular hexagon. For convenience and strength the hexagon is the most perfect, securing the utmost capacity for the storage of honey with the smallest expenditure of building material. That practically is the problem every builder is trying to solve to-day.

It is one of the problems of mathematics at what precise angle the three planes which com-

pose the bottom of a cell ought to meet, in order to make the greatest possible saving, or the least expenditure of material and labour. An ingenious mathematician has demonstrated by a fluctuary calculation, which is to be found in the Transactions of the Royal Society of London, that the precise angle required for economy of space and material is the very angle in which the three planes in the bottom of a cell of honeycomb do actually meet.

It has been shown that if the cells were made round they could never fit together, and not fitting would be liable to break. Much heat and space would be lost—both of importance to the bees. Square cells would fit well enough side by side, but the corners and angles would involve much waste of material. All these difficulties are avoided by the hexagon, which enables the cells to hold the greatest quantity of honey, with the least expense of material and waste of space.

Then the way in which the bees manage to combine strength and thinness in the cells is very ingenious. The combs must be strong so as to resist pressure and weight; but wax is a very costly product. It has been calculated

that the bees must consume fifteen pounds of honey in order to secrete one pound of wax. Hence the cells are made as thin as the thinnest paper, but by constructing them of two layers of wax a great deal of extra strength is secured.

Was it from the bees that the inventor of boxes made of several layers of wood got his idea? Then the cell is made with a strong rim so that it may resist pressure. But the most ingenious arrangement for obtaining strength is due to the little diamond-shaped pieces of wax at the bottom of the cells. The slightest alteration of angle, making the cell either flatter or more pointed, would destroy the perfection of the cell.

Is this merely instinct? It hardly seems possible, inasmuch as the bees do not work on one unchangeable plan. "It was really curious to note in cases of difficulty," writes Darwin, "as when two pieces of comb met at an angle, how often the bees would pull down and rebuild in different ways the same cell, sometimes recurring to a shape which they had at first rejected."

Huber, to whom the world owes so much, tells us that he *saw* (although he was blind and had

to depend on the observation of others) a bee building upon the wax which had been put together by her comrades. But she did not arrange it properly, or in a way to continue the work of her predecessors, so that her building made an undesirable corner with theirs. Another bee perceived it, pulled down the bad work before our eyes, and gave it to the first in the requisite order, so that it might exactly follow the original direction.

Such clever modifications of structure seem to indicate something more than blind instinct. Darwin, by an elaborate piece of reasoning and calculation, assures us that the hive-bee acquired inimitable architectural powers through natural selection. The theory leaves much to be desired. But all that is aimed at here is to show with what cleverness the bee has solved some of the most intricate mathematical problems, and so deserves to rank among the pioneers in that abstruse science.

CHAPTER XIII

THE CARPENTER

If the carpenter be defined—a little loosely perhaps—as a worker in wood, then quite a number of insects will be found in that category. Some of them may be said to have beaten the human carpenter in his own field. Instead of finding no use for sawdust till quite recently, when it has been utilised for paper making, the carpenter bee long ages ago not only made sawdust but utilised it for making houses for its young.

The Carpenter Bee, found in the south of Europe, is the largest known bee, and bulkier than our Humble Bee. The female will only work in well "seasoned" timber, as all carpenters should do. Dead timber must be cleared away, and it is by aiding in this that the Carpenter Bee is useful. If it tackles a gatepost, a fence, or a roof, that is a mistake of course, for which the bee is not wholly to

blame. Man ought to have put his private mark upon it by paint or creosote.

The Carpenter Bee bores a hole about half an inch in diameter in an oblique direction. Ere long she alters the direction and bores with her jaws, straight down. The sawdust thus made is carried out of the hole and stored in a heap for future use. When the boring is fifteen inches deep another turn is given to the direction, towards the outside. Next comes the carpenter work, the dividing, the boring into perhaps a dozen chambers, for the reception of eggs and food, each an inch in depth. The food consists of pollen and honey on which an egg is deposited.

Mixing a little sawdust with a salivary secretion the bee forms a ring with it right round the tube; and when this is set hard, another ring will be added till a floor is made an eighth of an inch in thickness, forming a separate compartment. On this floor another egg and food will be placed; and the formation of divisions and the storing of food and eggs will go on till a dozen chambers are completed. Another shaft will be made if the timber will allow.

In one of his books Fabre has shown that the

bee is quite ready to save labour by utilising a ready-made tube, if a hollow reed suitable for the purpose is at hand. By many ingenious experiments, Fabre discovered how the young bee will act under certain circumstances. The egg first deposited at the bottom of the shaft will hatch some time before the others. To pierce the floors separating it from the outer world would involve the destruction of the entire family. But the young bee cuts its way through the timber at its own end, and so leaves the rest of the family intact.

We have several carpenter bees of our own, though smaller in size than the Continental one just described. The *Osmia*, with which Fabre made many interesting experiments, makes her nest in a dead bramble stem, drilling out the pith, and then constructing her cells of the pith and placing them end to end.

A very remarkable thing about another species of Osmia making its nest in the pith of a dead bramble stem, has relation to the method of emergence of the young bee. If on finding the path of exit blocked by another cell it will not violate the cocoon, but will wait a week, perhaps, till the way is clear. If from any cause

the delay continues more than a week it may die; but it will not attempt to attain its freedom at the expense of another life.

There are many workers in wood both among wasps, ants and beetles. Of the latter the Longicorns, which number more than twelve thousand species, are all in some form workers in wood.

CHAPTER XIV

THE WHEELWRIGHT

THE Spider spins and weaves as everybody knows; but how cleverly and artistically only a few are aware. Let me say, again, at the outset, that the spider is not an insect: it has eight legs instead of six as is the case with all insects, and no antennæ. Like the insect it has no backbone; but while *cut into*, as the word insect signifies, it is into two and not three parts. Insects breathe from spiracles or openings in the sides; spiders by gills, underneath the body. Their eyes are not complex but simple, varying in number from two to eight. Born direct from the egg in spider form there is no caterpillar stage. The spider spins, not from her mouth like the caterpillar, but from her spinnerets, which are situated near the under end of the abdomen.

Spider means *spinning-one*—hence the word spinster; and a wonderful spinner she is. Her

silk is manufactured in her glands, and is given out from spinnerets numbering from four to eight, in large tubes (spigots), and a great many small ones (spools). The Garden Spider has about six hundred glands, but only manufactures five different kinds of silk. The snare or web of this spider, *Epeira Diadema*, is a piece of workmanship combining strength, delicacy, firmness, ingenuity, and something not far short of mathematical precision. It is an example of supreme instinctive art. For instinctive it undoubtedly is, notwithstanding the modifications of structure dictated by differences of site and circumstance.

The artist begins by sketching in a few rough foundation lines, varying according to the site. The spider may march round the limits of her space, spinning as she goes; or she may throw over the chasm a bridge in the usual fashion of spider bridge-building, the thread being blown across the space by an air current. Each outline thread will be carefully tested and tightened: foundations must be sound and reliable. Next the spider throws across the enclosure a radius of the future wheel. Another line will intersect this at the centre, the hub of the wheel being

carefully constructed as a thick white point. From this centre the spider carries the spokes of the wheel.

Let anyone try to make such a wheel of thread, and he will discover that he must not carry the spokes right round from the centre, for in tightening the line the whole structure will be pulled out of shape. Our artist is wiser. After making a few spokes she goes round to the other side of the circle, carefully adjusting each line and stretching it to the proper length, and collecting the slack at the hub.

The spokes, now inserted all round beautifully equidistant, our wheelwright, beginning at the centre, describes a spiral line with very close coils, which is to form the place from which the huntress will afterwards watch for her prey. Then with thicker thread and ever widening spirals, a temporary scaffolding is constructed. Presently this will be scrapped and eaten. To dispose of a whole lot of scaffolding in your internals, with an eye to future operations, must have considerable advantages. The next scaffold will thus be brand new.

Working from the circumference inwards, the spider brings into play another set of spinnerets,

from which the delicate but strongly adhesive spirals forming the true snare are exuded. Now the work is completed and the artist takes her stand at the centre to watch for the coming of the prey.

Clever artist as *Epeira* is, she is far surpassed by many American spiders, with their ribboned orbs, their horizontal snares, and their wonderful domed orbs, all revealing the skill of the consummate spinner.

The spider works by instinct from some plan or design, having its seat in her wonderful ganglion-brain, which may seem to us, when examined with dissecting knife and microscope, no brain at all. What and how she sees and works who shall say ?

That she works from instinct is proved by many things : among others by the fact that she cannot patch or mend her net. When her snare is broken she must scrap, practically, the whole and make a new one. Mending, we are told, requires reason, and the necessary mental adjustment for this is not provided for in the spider's economy. She works from instinct which is " due to inherited nervous mechanism, resulting in actions the object of which may be

quite unknown to the actors." That the wonderful and complicated snares of the spider are thus produced seems incredible ; and yet so keen and patient an observer as Fabre is satisfied that that is so. In the words of Fabre, " those wonderful manufacturers of silk-stuff lack the least glimmer of that sacred lamp, reason, which enables the stupidest of darning women to mend the heel of an old stocking."

CHAPTER XV

THE MINER

One of the most interesting of the caterpillar tribe is the miner. Multitudes have never seen it, nor suspected its existence; and yet it is to be found on rose-trees, the vine, the primrose and the alder tree—all familiar in our gardens and woods. The moment it is born it goes with a very business-like air to its work as a miner. You may invariably find the spot where it was born and the shell of the egg from which it emerged; and there, without wandering a hair's-breadth, it has dug itself in and commenced mining. Attention to business is the condition of its safety.

To this it may be said to sacrifice everything. All the world lies around. A thousand beauties are on every hand; without a moment's hesitation it surrenders them all. The sun, the air, its kind—all must be foregone for food and safety. Its motto is "This one thing I do!"

It has mastered the answer to the question: "What is the chief end of this caterpillar?" So we might say, judging by its behaviour. It may not know it—though how much a caterpillar knows, any more than a cat, we do not know—but its decision, its intent regard for food and safety, are all necessary if it is to attain the chief end of its existence—to become a thing of beauty.

To many, despite its points, a caterpillar is a loathsome thing, but a moth is always beautiful, and so is a butterfly. The great Creator is infinitely beautiful, and in everything He has implanted the passion of self-realisation. And that in one form or another is beauty.

Very interesting is the minute care with which the mining caterpillar does its work. Its course may be traced like that of a river from the upper side of the leaf. Like the river you may discern a dark, wavy line, and on each side a lighter portion resembling a valley. It seems extraordinary that in so thin a thing as a rose-leaf, thinner than the paper on which this is printed, a tunnel could be run, by a caterpillar which can there find hiding and food; and all without touching the upper or the under

surface. Both external membranes are left untouched. If we try to separate a rose-leaf we shall soon tear it. But this is not all: the caterpillar works with such minute care and exactness — and without any of the clever mechanical devices of the miner—that it leaves quite a considerable thickness untouched beneath its tunnel.

For this reason you cannot trace its course on the underside of the leaf at all. This shows that it eats only one half the thickness of the pulp, or that part which belongs to the upper membrane of the leaf. For certain lessons Solomon advises us to go to the ant: for others he might have advised us to go to the mining caterpillar.

The final achievement of the mining caterpillar is a thing of extraordinary beauty. From the chrysalis there emerges a tiny moth (*Œcophora, Latr.*) which is among the most splendid and brilliant of Nature's productions, vying in the rich metallic colours which bespangle its wings the splendours of the Humming Birds and Diamond Beetles of the tropics. To have followed the singular life story of the mining caterpillar through all its stages; to

have seen how through all its days it has shunned the light of the sun and immured itself in a mine below the surface of the leaf —which after all is its world—and then to see it rise from its chrysalis-like grave a thing of extraordinary grace and loveliness, is to experience an immense surprise, and once more to marvel at the wisdom and power of Him who " hath made everything beautiful in its time."

CHAPTER XVI

THE TUNNEL-MAKER

One day I came upon our Robin Redbreast carrying a leaf which he dropped. I found the leaf to be curled up as I expected, and inside the leaf was a tiny caterpillar. In summer you may find any number of these leaf-tunnels on trees and rose-bushes. But how has a caterpillar, without hands, thus cleverly curled up a leaf? Surely the leaf did not curl itself for the special convenience of the caterpillar.

Let us go back to that curled leaf dropped by Robin, and endeavour to reconstruct the history of that caterpillar. The leaf was from a lilac tree. Earlier in the year a pretty little chocolate-coloured moth deposited an egg on a lilac leaf. Presently the egg hatched, and out came a tiny caterpillar. It seemed in a great hurry to hide; and for a very good reason. It knew how many deadly enemies were around.

So it set to work at once to make itself a shelter. Crawling to the edge of the leaf—a long journey for so tiny a creature—it spun a fine silken thread which was gummed to one edge of the leaf. Inside its tiny body and in its mouth that caterpillar has the material and the machinery for spinning silk. The thread thus fastened at one end is carried across to the midrib of the leaf and the other end fastened there.

Another and another thread will be spun and secured in the same way until several are in place, like the strings of a fiddle. Then one of the caterpillar's tiny feet with its hook, is used to shorten the thread, which is bent down and glued fast. All the threads are treated in the same way; and if you had watched the process you would have seen the edge of the leaf gradually curling up. More spinning, shortening, and gluing goes on, till the edge of the leaf is made into a tiny tunnel. The same thing is done with the other half of the leaf until that also is drawn up to meet the first half. The edges are then glued together so as to form a gallery or tunnel, into which the little builder retires and lives out of sight

of its enemies. Here it feeds on the outer part of the leaf, now the inside of the house.

When you think of it you will be surprised at the cuteness of this little caterpillar which, the moment it is born, is aware of its dangers, and makes such a clever contrivance to guard against them. It is very wonderful; but Nature is full of similar wonders if only we would open our eyes to see them.

When the caterpillar attains its full growth it spins a chrysalis or cocoon or pupa. Surely it must be safe now having reached this last stage on the way to its becoming a moth like its mother. But that is not so; every stage of insect life has its dangers. Alighting on that upturned leaf a tiny ichneumon fly proceeds to investigate, and soon discovers that here is no wriggling caterpillar, but a chrysalis. Forthwith it sets to work. With its ovipositor it drills a hole through the leaf, with infallible accuracy, at the spot underneath which lies the pupa. The drilling is continued until the outer case of the cocoon is pierced.

Through the hole the eggs are deposited in the body of the unfortunate chrysalis, there to hatch and devour nearly all save the shell.

Then the hole is closed and the wicked little despoiler of beauty flies away, soon to die, having finished its life-work. Meanwhile the tiny grubs inside the chrysalis do their deadly work and presently emerge, a squirming mass of maggots. In a few hours they, too, will spin for themselves silken cocoons, from which in due course will issue a host of ichneumon flies. But no beautiful little moth can ever emerge from the gallery now; it is destroyed by the parasites which have fed on its substance.

The caterpillar preys on the leaf; the ichneumon on the caterpillar, or pupa, and Robin on them both. No blame to any of them. Each is fulfilling a great law of Nature for the preservation of balance, without which the world would be destroyed. Everywhere this law must be observed—among plants and trees, animals and insects, and men and women. What we call instinct provides for this, for the most part; but in humanity it demands the exercise of reason and conscience and religion. Failure here will involve disaster. "A prudent man forseeth the evil and hideth himself: but the simple pass on and are punished."

IN SOCIAL ORGANISATION

THE REPUBLICAN
THE MASTER ORGANISER
THE DUELLIST
THE HUSTLER
THE HANDY "MAN"
THE SEER
THE EMIGRANT

CHAPTER XVII

THE REPUBLICAN

WHETHER to call ants republicans, socialists, or communists, one hardly knows. They illustrate all three in certain aspects. Long before any of these were known among men the ants constituted a perfect republic, having all things in common, and each working for the good of all.

The only head of this Republic is the " queen," who, however, exercises no authority. Rather is she the great mother of the community. Her sole function is to produce eggs. If she seems surrounded by something like royal state, having her maids of honour, who guard her, feed her, fan her, clean her, and never turn their backs towards her, she is at the same time subject to her attendants, who will not allow her to go where she will, and occasionally will place her under restraint.

No doubt she is specially waited upon and

honoured. She is exempted from work. But her peculiar position is due to the fact that she is the fountain of life. Without her the life of the entire community will be jeopardised. Should she die, the citizens will ultimately perish, unless they find a successor to the vacant "throne."

It is in the organisation of the community that the perfection of Republicanism is seen. There is absolute equality. No section presumes to dominate another. If there are soldiers to guard the city and workers to carry on its various operations, this does not give any class ascendancy over any other. How the division of labour is effected we do not know. Why some become guards, others builders, and yet others nurses, is a mystery; for there is no coercion exercised, and nobody apparently either to teach or rule.

Some authorities tell us that the young ant does not come into the world with an instinctive knowledge of all its duties as a member of a social and highly organised community; and in need therefore of teaching. Others allege that immediately on its release from the cocoon and the necessary "licking" from the

tongue of the attendant nurse, the young ant will begin some form of work. There may be some truth in both statements. At first the young ant is weak, and may readily be distinguished from the others by its lighter colour.

My own experience is that within a very short time it will be busily engaged in some form of work. This seems due to instinct rather than training. How and why that minute but wonderful ganglion-like brain indicates to the new-born citizen what duty she, as a neuter, has to undertake is a mystery, but only one of a thousand similar mysteries in the insect world.

But could a more perfect Republic be imagined? Here is entire subordination to the public weal. Here without cavil or dispute each finds the right place and fills it from the beginning of life to its close. This is indeed a Commonwealth: for all live and toil for the common good. Every duty is undertaken and carried out without the intervention of any Boss, or Labour Exchange. When roads are required, for example, without any education or training in making cuttings or macadamising, labourers will immediately spring out of the

ground and reveal a strength and skill and perseverance amazing to behold.

And in this Republic we find no quarrelling, no intrigues, no rebellions. Whether in some far-off, dim and distant age, there was any difficulty in settling down, so characteristic of young Republics, we do not know. Now there is universal and instinctive obedience to law. Only once have I seen ants of the same nest fighting, and that was due entirely to my unwittingly having made them incapable of recognising each other. These Republics do sometimes make war on each other, or on ants of another nest, or species, but within their own borders they dwell together in peace. They know each other, defend each other, help each other in a thousand ways. Humanity has not yet learned the secret of this wonderful Republic. Be that secret what it may, it is certain that never until the perfect law of love has become universal, if not instinctive, will men live in perfect harmony and brotherhood.

CHAPTER XVIII

THE MASTER ORGANISER

MUCH is heard to-day of the importance of organisation; the man with the gift of organising is everywhere in request. One of the most extraordinary examples of this is a beehive. To speak of the honey bee, however, as a clever organiser would not be quite correct. An invisible something may be said to have the credit for the consummate organisation of the beehive. To realise the supreme gift of this invisible organiser we must study, first of all, the organisation itself.

In the beehive you have the most perfect division of labour. A bee has just returned from her work in garden and field or moor, bringing a tiny supply of the precious nectar. This is taken charge of at once by a particular set of workers to whom, somehow, this particular duty has been assigned. Their duty is to transform this nectar into honey. But the

worker has also brought a supply of pollen, and this will be consigned to another set of experts. That may not be the right word; possibly a bee can "turn her hand" to anything in the hive, but it will serve for the moment. If in addition a store of propolis has been brought by this indefatigable toiler, there will be some section of skilled "craftsmen" to receive this and to employ this wonderful cement in some part of the city building.

If you look around the city you will discover nurseries of the young, where the cleverest nurses are busy tending the babies of the community.

But what is that crowd surrounding some object of special interest? They are maids of honour whose duty it is to be in attendance on the Queen, the centre of the life of this wonderful Republic. A Queen in a Republic seems a contradiction of terms; but this Queen exercises no authority; she is ruled rather than rules, and yet is the most indispensable member of the community. Longer than the other bees, shorter of wing and more tapering and graceful of abdomen, she is the source of life, and in a few years will produce probably a

million eggs. There is a certain significance, no doubt, in the fact that her maids of honour always stand with their faces towards her. But nevertheless her majesty neither reigns nor rules.

This wonderfully organised community includes a class, which though indispensable, bear the contemptible name of Drones. Large and burly, they will neither work nor want. As the males of the community, greedily devouring the honey that has cost so much, their life is a short one, and presently they will be put to death. For such shirkers bees have short shrift.

That the greater part of the inhabitants are collectors of nectar and pollen is no doubt true. Of them we all have knowledge. But what are these other workers crowding together, the temperature of this part of the hive having somehow been strangely increased? They are busy making wax, a concentrated essence, which is elaborated at great cost in the bees' own bodies—for it takes fifteen or twenty pounds of honey to make a pound of wax.

Yet another class of workers are using their wings like fans. Fresh air is needed in the hive day and night, and the temperature must

be carefully regulated. Long ago the bees solved the problem of ventilation without draughts. This is secured by the wings of the ventilating company. The hum that may be heard from a hive of bees is due to the rapid oscillation of these vibrating wings.

The inhabitants of the city whose duty it is to make honey out of nectar must not be forgotten. The essence of the flowers is transformed and enriched by the bees' own vital secretions, and so becomes the honey we know.

The task of carrying the wax, secreted by that great crowd of bees densely clustered together to produce warmth, must be performed by another class of toilers; and perhaps others again must build the cunningly formed hexagons of the comb. Then there are the sentinels who keep watch at the door and guard against the entrance of enemies.

A marvellous organisation surely! But who and where is the organiser? Nobody has ever discovered that wonderful bee. The organiser is invisible: for it is that mysterious something which Maeterlinck has called "the spirit of the hive," the last and profoundest mystery of this marvellous Republic.

CHAPTER XIX

THE DUELLIST

THEY fought neither with pistols nor swords nor rapiers, but with stilettos of a temper and keenness that no Toledo blade could rival. It was a fight to a finish—each resolved to kill or be killed, to conquer or die. Royal duellists they were, and as rivals for the throne they fought with a bitterness of hate, a malignant determination to murder, and a fury indescribable. The occupant of the throne was fiercely jealous; she could not brook a rival, and was literally mad to kill.

So much for the *casus belli.* Now a word as to the weapons. A bee's sting—for our duellists are rival Queens—is a wonderful thing. Most people have observed that after a wasp has been killed it will still continue to dart out its sting. This, however, is not the true sting but the protecting sheath, which prepares the way by penetrating the tough skin of the victim.

The whole mechanism consists of three pieces, regulated by a complicated set of muscles and levers, and connected by a tube with the poison-bag. These pieces are the sheath, two three-sided needles, each bearing six barbed hooks at the end. The sheath has on its lower face a deep groove. In this the needle slides to and fro. Each needle is kept in its place by a complicated arrangement of hairs and studs, and the needles are worked by strong levers and powerful muscles.

If ever you had the misfortune to be stung, you will remember that the whole thing was the work of a second; and yet the following pretty accurately describes what happened: the muscles and levers sent the sheath into the skin. A strong piece of horny material caused both sheath and needles to turn sharply upward, which slightly enlarged the wound. Then by a rapid alternate movement of the levers the "needles" were driven in deeper. The concave inner faces of the needles were brought together, thus forming a tube. Down this tube the poison was driven by the contraction of the muscular walls of the poison-bag. The poison escaped from the points of the needles, and also

through five minute canals, that pass obliquely from the poison groove through the bases of the first five barbs. And all this complicated mechanism was operated in the fraction of a second.

And what an exquisitely finished weapon is that sting. Compared with the finest needle, seen through the microscope, it is without flaw or blemish, polished to the last degree, and ending in a point of invisible fineness; whereas the needle shows a rough, uneven, irregular surface. Sixty thousand bees, in charge of a commodity commending itself to the taste of insects, animals and men, are not quite defenceless, each armed with such a formidable weapon.

Such then are the weapons with which our duellists are armed, as each manœuvres for position so as to inflict a deadly sting. The extraordinary thing is that should both secure such a position as would result in a double tragedy, then they release their hold of each other and recommence the struggle. The supreme consideration, after all, is not the death of a rival, but the perpetuation of the race.

Where can such another example be found of race-regard triumphing over self-regard?

That two creatures, filled with murderous rage against each other, should thus refuse to kill is marvellous indeed. The duellists with all their savage hate, their twistings, their manœuvrings, still remain under the control of the master-impulse, the spirit of the hive—that mysterious something which is at the back of the whole wonderful organisation. At length one of the duellists manages to insert her lethal weapon in a vital place, and becomes the victor.

The succession settled by combat, the triumphant Queen is at once accepted as sovereign to reign though not to govern. Yet her mysterious influence extends to all the ramifications of the life and activities of the hive. Without her it would fall into chaos and confusion and speedily die. She is welcomed with extraordinary manifestations of reverence and delight, and the multitudinous activities of the hive—arrested for the time—will be resumed.

CHAPTER XX

THE HUSTLER

CLAD in shining armour, radiant in beauty, and of fearless mien, the hustler swept on whirring wings through the open window into the breakfast room. "A wasp! a wasp!" was the cry. Someone rose and boldly attacked the intruder —with a table-napkin.

Why treat so scurvily this beautiful visitor? For a simple reason: the beauty is armed with a sharp sting and behind that a poison-gland. And that is not all by any means. She is the champion hustler of the world. Into the brief period of some six months the wasp, emerging from her winter sleep, dusty and dishevelled, will crowd the tremendous task of building a fairy city, with a population of anything from 6000 to 60,000 inhabitants—a veritable commonwealth, splendid in its beauty, perfect in its organisation.

This White City, a miracle of industry and

concentrated energy, is founded and built by perhaps the most tremendous worker in creation. During the first month the Queen must, single-handed, so to speak, excavate the space of her city, gather the materials, build the cells, and surround the whole with a triple envelope of damp-proof material of her own manufacture. She must collect all the food required for her young family; and only when she has created the nucleus of her vast army of assistants can she remit her ceaseless labours and devote her time and energy to the production of thousands of eggs.

Then with what tireless energy the workers carry on the varied activities of the growing city. Here, to the last degree, life is keen, tense, energetic. Even the males, unlike the drones of the beehive, must work for their living as the scavengers and undertakers of the community.

Behind this wonderful achievement is a marvel of adaptation. To begin with the Queen must play the "navvy," in beginning that work of excavation which her children will afterwards continue. All wasps do not build underground, but the one under consideration does so. After

excavation, the work of paper-making, already described, must be undertaken.

Mason-work must next occupy this extraordinarily versatile creature. The foundations having been cunningly fastened to the ceiling of the little chamber, a house within a house must now be constructed, an apartment or hive completely isolated from the shell which encloses it. This builder knows all about damp courses and hollow walls, and has no intention that the citizens shall suffer from rheumatism. Everything is done in what builders' specifications call a workman-like manner.

There is wonderful architectural skill revealed in another respect. By and by there will be an enormous population and crowds of citizens will pass in and out. Sixty a minute I have counted. To avoid confusion and waste of time and energy, the city has two gates, one for exit the other for entrance.

And all this tireless activity, this vast expenditure of energy, is not for the wasp herself. She stores no honey and makes no provision for the future. It is all for the prepetuation of the race. The incessant toil, the clever adaptation, the gathering of food, are all for the

sake of the commonwealth. As the great French naturalist, Michelet, has said: "That this insect which has no time, which perishes in the evening, should love the time that never will be its own, should immolate its little life for the sake of the life that is to come, should devote to the child of to-morrow its solitary day, is a sacrifice peculiar to the wasp, original and sublime." Remember all this, and a few other virtues presently to be told, when next you hear the cry, "Kill that wasp!"

CHAPTER XXI

THE HANDY "MAN"

It is amazing how many of the activities of the home, the community, and of the state, have their counterparts among the ants. They were indeed among the earliest of our pioneers. Long before man appeared on the earth they were house-builders, road-makers, nurses, agriculturists, soldiers, horticulturists and undertakers. Their houses have many apartments, for the storing of food and the nurture of the young. The latter are classified according to age and placed under the care of nurses or attendants. Not that any superior authority determines the duties of ants.

The wonderful thing about the Republic—for the queen cannot be said either to reign or govern, her sole function being the production of eggs—is that each member of the community takes her own line, and almost from the hour of birth sets about her self-appointed duties. Just

how instinct works here we cannot tell. In this ideal Republic all serve and there is no difficulty about the division of labour.

When an egg is deposited by the queen, an attendant will seize it in her mouth, moisten and cleanse it with her tongue, and then transport it to the place appointed for the incubation—if so we may term it—of eggs. There other nurses will take it in charge, washing, fanning with their antennæ or feelers, and almost brooding over it, until there emerges a tiny grub or larva.

This will be removed to the place appointed for babies. The nurses keep baby most scrupulously clean with their tongues, feed it out of their own stomachs until, when full grown, it will spin for itself a silken cocoon or chrysalis. These cocoons are the so-called ants' eggs of commerce.

A most amazing thing is that certain ants have utilised this cocoon spinner to sew together the leaves of its dwelling. When the larva begins to spin it is held up to the leaves it is desired to join, and is thus made to sew them together. Is this instinct or reason?

The cocoons are removed to the place ap-

pointed for them, and their attendants are equally scrupulous in keeping their charge perfectly clean. No food is needed. Inside the tiny shell the mysterious changes are taking place from grub to imago, or fully developed insect. The nurse knows when the process is completed, and at once rips open the side of the cocoon with her mandibles, and carefully assists the birth of the youngster. After being duly cleansed the new arrival begins her life-work.

What, if any, orders are issued by the attendant we do not know. If it be a young prince or princess that is born, the wings will be methodically licked over and liberated, a most interesting operation, as I can testify from observation. These royal highnesses are fed and carefully watched to prevent their escape, till the day appointed, when they all leave the nest and take their one and only flight. "Flying ants," they are called by the uninitiated, who speculate curiously as to the meaning of the extraordinary phenomena of thousands of ants flying in the air and dropping in showers to the ground.

Road-making seems to be a distinct occupa-

tion—if occupation it can be called, where the inhabitants often seem able to turn from one kind of work to another. Road-making may be watched at leisure in a formicarium, and an interesting sight it is. I calculated that in an area of twelve feet square there could not be less than five lineal feet of roads, over which the ants constantly travelled on their various errands.

Soldiers defend the city, and in some species are equipped with formidable fighting jaws, or mandibles. When a death occurs, the deceased will be transported to the place appointed for all living—or dead. There are ants, though not in this country, which keep an area cleared of weeds, etc., where they reap the grain, storing it for use in the nest, and there taking the utmost care that it shall not sprout and be spoiled. So Solomon was right after all.

Other ants in tropical lands, known as Saüba ants, described in Chapter IV, repair to the forest where each will cut for herself a leaf, the whole army returning to the nest laden with spoil. The leaves are carefully minced, packed into suitable chambers, where they are soon

covered by fungus thread, upon which minute mushrooms make their appearance. These are gathered by the ants as food for themselves and their larvæ.

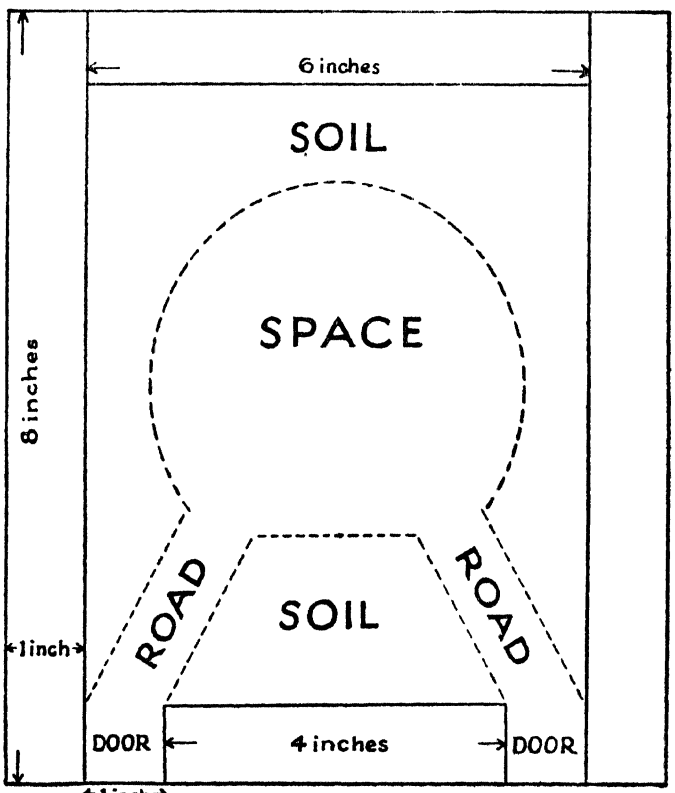
The British ant most suitable for domestication—so to speak—is the Yellow or Meadow Ant (*lasius flavus*) or according to some authorities (*Acanthomyops flava*). With this ant Sir John Lubbock, afterwards Lord Avebury, made his famous experiments. The common Black or Garden Ant (*formica fusca* or *niger*) is not nearly so interesting in captivity.

And here let me give the reader a hint which did not come to me till I was well over fifty—how to make a formicarium, so as to have ants under observation. To watch them, especially by electric light, at their various avocations, is a sheer delight. Two pieces of glass eight inches square will form the top and bottom of the formicarium. For sides, two other pieces eight inches long, one inch broad and an eighth of an inch thick. One piece for the third side six inches long, an inch wide, and an eighth thick. For the fourth side a piece four inches long, an inch wide and an eighth thick. This will allow two doorways

an inch wide each. The flat pieces of glass to be fastened to bottom square by seccotine. Now fill half the space with finely sifted soil so as to leave a space in the middle and two roads one from each door. Slightly moisten the soil by means of a syphon pen-filler to keep soil from shifting. Now fasten on the top square in place with cycle-clips. Get a supply of ants. A small tabloid or other bottle will serve to carry them home. Secure queen if possible. She is thirty times larger than the worker. The problem of getting your ants to enter their new nest is simple, when you know how.

Place your formicarium on a piece of wood nine or ten inches square. Cover glass top with cardboard, to darken it. Place the whole in a large tray; surround with water, so forming an island. Put a little soil at the door of each opening. Now dump your ants on top and they will find their way into their new nest in an hour or two. First guide the queen by means of a camel's-hair brush into the nest, lest she get into the water and drown. Close doors with cotton wool which no ant can pass. Feed once a week with drop of honey placed

on inside of cotton wool, and introduce a teaspoonful of water once a week. I have had seven or eight nests in my study for years. Of course, when your ants are inside you discard tray, wood and water.



CHAPTER XXII

THE SEER

A SEER is one who foresees future events. Surely it is absurd to attribute faith, or the gift of the seer, to an insect. But what is faith? "The substance of things hoped for, the evidence of things not seen," or as Dr Moffatt puts it, "to be convinced of what we do not see." Of course it is really instinct in the case of an insect, but an instinct so marvellous and baffling that it often seems more like reason than anything else. It is frankly, therefore, an accommodation of the word to call it faith here. But let us look at the facts, which are so extraordinary as to excuse even the use of a religious word to describe them.

The Digger Wasp is our shining example. Unlike the common wasp it is a solitary insect, building a separate nest for each egg it produces. As there are a great many different species, the best way perhaps will be to group

the most striking features of them all. The majority of them are energetic, fussy, bustling insects, and found mostly in sandy districts. Black in colour as a rule, they are lovers of the sunshine, and disappear as by magic even if a cloud covers the sun.

They all have an instinct for digging. Their long hairy legs have a large first joint, or coxa as it is called, with which working backwards, they push the soil out of their burrows, discharging it in a little stream when they reach the surface. Often enough their tunnels will be driven to a depth of several inches. Without any teaching they do this from instinct.

Having prepared its burrow the wasp flies off in quest of a spider or a caterpillar, as the food of its future young. The funny thing is that having found one it is instantly seized with a panic of fear lest some mishap should have befallen its burrow. Perhaps a rogue has seized it, or the sand has fallen in and filled it. So, leaving the newly found prey behind, it flies off to make sure that all is right. Returning to its prey it sets about the task of getting it home. Yet once more panic seizes the little Digger, and making a hasty *cache* of its

prize it must fly back again to see that all is well. Is this extreme watchfulness instinct, or the teaching of experience? All wild things know that eternal vigilance is the price of safety.

And now for a bit of the most extraordinary insect "science." Directly on emerging from the nest the Digger's young must not only have food but fresh meat. The wasp buries egg and food together; but as it will be some time before the egg is hatched, provision must be made against the meat going bad. If the prey is killed it will go bad; if not killed its movements will destroy the egg, or the newly hatched grub. The prey must therefore not be killed but merely paralysed. This is accomplished by stinging it in precisely one spot. The wasp knows all this and also how to insert the sting with the most scientific accuracy in the exact spot where it will effectually paralyse, without killing, the prey.

Another and even more wonderful proof of scientific accuracy is given by the wasp when the caterpillar is got home. I am assuming now that it is the kind of Digger wasp that uses a big caterpillar for this purpose, or it may be,

several caterpillars. In the case of a spider the egg is always deposited on a given spot so that when the grub emerges the food is there in readiness for it; but with the particular wasp with which we are dealing, the prey is a caterpillar, and the complete paralysis of a caterpillar is impossible.

What must be done? To place the egg on the prey would be to risk the smashing of it by the slightly wriggling caterpillar. What the wasp does is to suspend the egg from the roof of the burrow by a silken thread. On emerging the grub does not quite leave the shell, but reaches out to the nearest caterpillar and makes a meal of it. As it gets bigger the danger of being crushed becomes less, and presently, having grown strong and lusty it descends boldly among the prey and feeds royally.

All this happens days after the wasp has filled up the burrow and gone its way, never to see or know the baby for which such careful provision is made. And yet, speaking again the language of accommodation, it has already seen it by faith, and cared for its welfare. This filling up of the burrow is most carefully done. The surface must have no appearance

of having been disturbed—nothing to attract the attention of some thieving rogue. To the last detail the work must be completed. Dead heather-bells or pine needles will be gathered together and scattered haphazard over the place to give it a natural appearance. Clever, faithful Digger Wasp!

CHAPTER XXIII

THE EMIGRANT

For the first human emigrants we must go back thousands of years. Precisely what the first men were like, as they fled before the cold of the ice age, we do not know. Our ideas of man in that far-off time are very vague and indefinite. But emigration and migration are not confined to humanity. There are temporary migrations like those of the birds, who regularly leave this country on the approach of winter.

The instinct which impels and guides them is a profound mystery. The previous experience of the older birds furnishes no explanation. The young cuckoos do not leave this country till some time after the older birds have taken their departure. How do they find their way over vast distances never before traversed?

Our concern just now, however, is with the migration or emigration of bees when they

swarm. Although we use the word emigration when it is the case of leaving one country for another, and migration when it is only a removal from one part to another of the same country, the distinction scarcely applies in the case of bees, to whom a journey of even a few hundred yards may seem as serious an undertaking as emigration to us.

Many theories have been advanced as to the cause of swarming—over-population and consequent lack of room; a superabundance of food; and excess of nurse-bees in proportion to the young to be fed. This last is the most recent theory. The idea that plenty of room would check swarming is contradicted by the behaviour of imported Italian and other bees, with whom it seems to have no effect. Nor does it seem to be a question of food-store; an entire apiary swarmed this season when there was little honey going, and will have to be fed through the winter.

With a "land" flowing, if not with milk, yet with abundance of honey and pollen and propolis, with a population of, say, ninety thousand, one hundred and twenty pounds of honey, ten thousand eggs, eighteen thousand larvæ, thirty

thousand nymphs or pupæ, it must be either lack of room or an overplus of nurses that originates the urge to emigration.

Anything from forty to sixty thousand bees will leave this hive of plenty to make a new home in the wilderness. Do they know where they are going? Scarcely. Scouts may be sent out to act as spies, or to locate a new place of abode, but only at the hour of departure. Nor is it a case of desertion, since they leave behind them enough workers for all purposes.

Some are disposed to fall back on Maeterlinck's explanation of the many mysterious happenings in the life of the bee—the instinct of the hive, a kind of public spirit which regulates the organisation and entire life of the community. Some intimation goes forth from the reigning Queen that she intends to seek a new home, and a large part of the inhabitants decide to accompany her. Various devices have been employed by bee-masters to prevent swarming, more or less successful; but the instinct or spirit of the hive remains often incalculable.

The actual swarming or "going off" is one of the most impressive sights of the insect-world. The air seems full of bees, and thousands

will be flying in the neighbourhood of the hive. There is not only an extraordinary noise, but a note in it peculiar to the occasion. Not far will the swarm go in the first instance. Accompanied by the Queen they settle on some nearby bush or tree. I have known them choose a branch high up on a tree. The bees gather in a cluster which may be the size of your fist or as big as a football.

A big swarm may depend two or three feet from the branch to which it clings. The scouts may decide as a permanent abode on a hollow tree, under a roof, or some empty hive. I remember once having the luxury of eating honey from the comb, held in the hand like bread, which had been taken from a hollow tree, in autumn.

Before swarming, the bees gorge themselves with honey as food till the new home is found, and as material for making the first combs of the new city. When the signal is given, which may be after the lapse of hours or even days, the bees take their flight in a dense swarm to the place chosen. Usually the owner provides them with a skep or hive, into which he deftly shakes the swarm. The Queen inside, the rest

will usually follow readily enough. Then quickly the whole population will set to work, each to her task, apparently without orders given or compulsion exercised—feeding and attending the Queen, ventilating the hive by the incessant vibration of their wings, nursing the young, toiling as architects, masons, workers in wax, sculptors, collectors of nectar, makers of honey, chemists for the preservation of honey, capsule-makers to seal up the hexagonal cells, street-sweepers, sanitary officers, executioners, under-takers, and city guards.

IN COMMUNICATION

THE TELEPHONIST

THE AERONAUT

THE WIRELESS OPERATOR

CHAPTER XXIV

THE TELEPHONIST

TIME and the wireless have dulled the edge of our astonishment in regard to the telephone; but we can still recall our surprise on hearing for the first time a familiar voice over the telephone, scores, perhaps hundreds, of miles distant. And yet in the insect world these marvels in some form have been in operation for ages.

Fabre, as we have already seen, hazarded the speculation of wireless as the only explanation of the way scores of Peacock moths flock to a given centre; and he it was who first discovered the use of the telephone among spiders. He found this among several species of the Garden Spider (*Epeira Diadema*). From the centre of the circular web there runs, well overhead, an independent thread right to the spider's den. It may be twenty inches or eight feet in length. This is used as an aerial footbridge by which the

spider hurries to any game that may be caught in the snare.

But the spider can travel over any part of the web, and the use of the thread as a highway may have concealed its more important purpose. The fact that a fly has dropped upon the snare is signalled at once to the spider, which hurries to the scene. For, starting from the centre, or hub, of the wheel, there is a telephone in connection with the whole of the web. And a wonderful contrivance it is.

But how do we know that this is the real purpose of the wire, if so we may term it? Fabre proved this by a number of interesting experiments. First of all he found that game placed on the snare always brought the spider to the scene. Then he cut the thread, and the spider seemed from that time quite unaware of the fact that anything had touched the snare. However a locust might struggle the spider remained in her den, apparently "wrapped in profound meditation." Here was evidence that only by means of the wire was the spider aware when game was caught. Cut the "wire" and communication ceases.

But how does the spider learn from her

telephone what is happening out on her web? She has her back to the web and is unable to see any part of it, even if her sight were good, which is not the case. But one of her hind legs is stretched outside her den, and just at the tip of that leg the signalling thread ends. "Whoso has not seen the *Epeira* in this attitude, with her hand, so to speak, on the telegraph-receiver, knows nothing of one of the most curious instances of animal cleverness."[1]

Then the spider's ear must be in her leg? And so it is. A locust quickly brought the spider on the scene. But next day, after the "wire" had been cut, neither dragon-fly nor locust, flutter and kick as they might, served to rouse the occupant of the den. She did not even turn round to see what was going on. "Clutching her telephone-wire with her toe the spider listens with her leg; she perceives the innermost vibrations; she distinguishes between the vibration proceeding from a prisoner and the mere shaking caused by the wind."

The *Epeira's* method of dealing with big game is suggestive. Turning her back to her struggling prize she works all her spinnerets and

[1] Fabre's *Life of the Spider.*

gathers the silky spray by her hind-legs. She thus obtains an iridescent sheet, the component threads of which are always separate. By rapid alternate armfuls this shroud is thrown upon the prey, which is turned over and over at the same time, so as to swathe it completely. If one armful of fetters does not suffice, a second, and if necessary a third, will be thrown. Then she gives the game a bite, and retires a little till the poison has done its work, when she returns to make her meal.

The telephone seems to be the product of age and experience in the case of the *Epeira*. At any rate the young do not resort to it, partly because their webs are made of more delicate material and require to be renewed every night or early next morning; partly because they do not mind the drudgery of incessant watching. Rather a reversal of the usual order in one sense. And yet in another it seems fitting that the yoke should be borne in youth. If the telephone is the product of age it is an evidence of the value of experience. But that is another story.

CHAPTER XXV

THE AERONAUT

For ages man has been fumbling after a thing which insects and animals have done with ease and perfection from the beginning. For thousands of years men dreamed of flying, but knew it was only a dream. Indeed flying was a synonym for the impossible: "you might as well talk of flying." Nevertheless the dream issued in action. Man must try to fly, at any rate. Attempt after attempt was made; machine after machine constructed; each a trifle less futile than the last. To-day all the world is familiar with how, at last, the thing was done; and apparently the birds are just as familiar with, and indifferent to, the sight of a man flying as ourselves.

And we are only at the beginning; it is impossible to say where and what the end will be. It seems but yesterday that the motor-car was little more than a curious and unreliable

toy: we all know what it is to-day—so swift, so reliable, so easily controlled.

After an apprenticeship of thousands of years man has learned to fly; birds and insects have done it to perfection almost since the beginning of time. Yet herein lies man's patent of nobility. The little spider of whose feats this chapter will tell, will never improve on his method of flying, but no limits can be set to man's development in this or any other direction. The spider is not an insect, having eight legs and not six. Nor is it gifted with wings. That any of its species should take to the air, therefore, is analogous to man's trusting himself to that element.

Our aeronaut is a mere speck floating in the air, only to be seen in a proper light. The fact of its arrival is notified to you when you get a glimpse of it depending from your hat brim by an invisible thread. But few know that it has arrived by a flight as adventurous—and for its size as long and extraordinary—as that of the daring aeronaut who sets out on a flight round the world.

Let us see the starting point of this audacious achievement. It did not escape you that the

spider was small; but it might have been a monster of venomous iniquity from the ruthless way in which you snapped its thread and consigned it to oblivion. As a matter of fact it was a member of a very large family, whose home was a thing of wonder and beauty, fashioned with extraordinary skill out of the finest material. The lining of that exquisitely fashioned home might be of silk, or of the softest eiderdown, whose beauty and fineness no loom of man could ever rival. One day it burst open, or was torn open, and from it poured a swarm of probably hundreds of tiny spiders, each perfect to the last detail.

How to get a living is the question which faces them immediately. In a place overpopulated a hundred times it is quite impossible. Emigration is the only solution of the problem. It is said there is a season when a young man's fancy lightly turns to thoughts of love; those of our young spider, not lightly but with the vehemence of an irresistible urge, turn to climbing. It will climb anything—a tuft of grass, a plant, a bush—and climb and climb till it reaches the top. Not from this Pisgah's height would it survey the promised land; that

land is too distant to be seen, even to one gifted with such eagle eye as no spider ever possesses. The little spider's one passion is to get as high as possible. That is necessary if his aeroplane is to get a fair start.

Now that the long climb is ended let us see what the little fellow is up to. Get your pocket-lens on him, and you will discover that he is running up and down with amazing activity. Then you perceive that threads are issuing from his tiny spinnerets. You may not see the threads they are so tiny, but they are there. The final thread having been got to his satisfaction in length and strength, it is detached so that the lightest breeze will carry it away like a floating streamer. At one end the thread is anchored to the bush or plant.

Now the spider runs along his thread, working his tiny legs for all they are worth. If, fortunately, the sun gets a glint on that thread behind it will become visible; for the spider is spinning an additional cable as he goes, so that the thread is now double. In front the thread is too fine to be seen, but it is there assuredly. With all his cleverness our little aeronaut can-

not walk on nothing; but having got on his "machine" he is ready to be off.

Presently the breeze gives the cable a little pull and it snaps, and the spider is seen flying through the air, until, finally he passes out of sight in quest of a new territory. The great exodus is achieved, and the needed dispersion of a large family accomplished. By and by gravitation and his clever parachute will bring the aeronaut softly and safely to earth, where he will settle the food problem in his own way. He knows if we don't.

What wonders are here: an infinitely tiny mechanism forming the instinct of the little spider by which he is impelled to do all these things; a courage to set forth on a quest not knowing whither he goes, and with no chart or compass; an audacity that launches itself on nothing, trusting to the tender mercies of an unknown element. "O Lord, how manifold are thy works! in wisdom hast thou made them all."

CHAPTER XXVI

THE WIRELESS OPERATOR

THE reader may now begin to wonder in what insects, and especially ants, may not be pioneers. Almost every human occupation has been anticipated in one form or another. How far animals possess in some way the gift of speech among themselves has often been a subject of discussion. But what of insects? Have they some form of speech? And do they give or obtain intelligence over great distances, by what seems to us akin to "wireless" or something even more extraordinary?

If in either respect the insect world has anticipated the achievements of humanity this must rank among their greatest wonders. So far as can be gathered their method of communication resides in the antennæ.

The word antenna is from the Latin and signifies a sailyard. The idea is of something spread out like the sails of a ship. There the

analogy appears to cease, for a ship's sails are for propulsion and not for a means of communication. Nothing is more wonderful or mysterious than the antennæ of the insect, so far as their structure is concerned. They are often very beautiful. In some, as with gnats and moths, they are often like plumes; and it is not improbable that they help the insect to steer a straight course. I remember an ant once that had somehow lost an antenna, and it went round and round in a circle.

But the common name, "feeler," is not without significance. By means of its antennæ the insect seems to feel its way, even when it possesses hosts of eyes. It stretches them out to the unknown in order, apparently, to discover what is there. Around is a vast and unknown world, and blind or seeing, the creature may wish to test it to the utmost. Certainly blind ants and bees in their hives are greatly dependent on their feelers. But there may be much more than a kind of instinctive feeling involved here. There is often a suggestion of hearing and of something more, as we shall see just now.

In the antenna there evidently resides the

organ of smell as a means of identification. Two ants meeting, invariably demand of each other the countersign, or something of the sort. By touching antennæ they decide between friend and foe. Do they recognise each other chiefly by smell? I remember once when changing ants to a fresh formicarium, I picked up the "queen" and a number of her maids of honour with a camel's-hair brush. I wished, first of all, to see the queen safely inside the new formicarium; the rest of the ants would follow.

Soon afterwards I was amazed to see the ants fighting. Amazed, because ants of the same nest never quarrel. Then it dawned upon me that a few days before I had used the camel's-hair brush with clove oil, the pungent odour of which still clung to the brush, so that the ants touched by it still retained the odour, and were no longer identified as friends. I lost a number of my colony in consequence of the battle, but perhaps the knowledge gained thereby was more than worth the price. It would seem therefore that the sense of smell resides in the antennæ.

What of hearing? These organs are found in the antennæ of some grasshoppers; but ants and bees seem to be deaf. They appear

able to signal to each other, and have certain countersigns which serve as "passwords" of admission. Bees have been known to change the "password" when they had evidence that another hive were using the same, and thus obtaining admission to the stores. The antennæ, however, do not always serve for hearing; some spiders have the organ in the leg.

As to speech, ants can very quickly summon their comrades to any food they have discovered, as Lord Avebury proved again and again. Have the insects anticipated us by one or other of our methods of communication, telepathy, for example?

But there is more than all these to be found in the insect world. Fabre's experiments with the Great Peacock Moth are astounding.[1] He tells how a female emerged from her cocoon one day in his presence. For the sake of observation he imprisoned her in a wire gauze. That night the room was full of Great Peacock Moths. They were all over the house. The wire-gauze cover was the Mecca of their flight. In spite of stormy weather this was repeated for eight nights.

[1] "Social Life in the Insect World."

How did the invading host know of the presence of their mate? Was it by means of their antennæ that they scented the whereabouts of the imprisoned moth? By means of sharp scissors the antennæ were severed, apparently without occasioning any inconvenience. Still they came—one hundred and fifty of them in eight nights. The Great Peacock seemed to be very rare in the neighbourhood, so that the bulk of them must have travelled many miles. A series of experiments extending over several years eliminated sight and sound with certainty, and only smell remained.

At length the conclusion was reached that it was only after the moth had been settled for some little time on a given spot that the attraction was exercised. Removed from a twig in one part of the room to a cage, the invading swarm would make straight for the empty twig and pass the occupied cage near the window. Clearly what attracted the moths was some odour distilled on the twig, and only becoming operative after the lapse of a certain interval of time. But how detected from long distances? Not by the wind, for the moths came from the opposite quarter. Fabre came

to the conclusion at last that something analogous to our wireless telegraphy must be the explanation of the mystery.

Returning for a last guess to the sense of smell, mention may be made of Fabre's experiments and speculations in "A Truffle Hunter," in which he tells how a certain black beetle, which lives on a kind of fungus growing from a foot to two feet underground, can detect the presence of its food, which apparently has no sort of special smell, and will dig a shaft right down to it with unerring accuracy. How does it discover the truffle? Fabre hazards the speculation that odour, like light, has its X-rays. "Let science, instructed by the insect, give us a radiograph sensitive to odours, and this artificial nose will open a new world of marvels."

IN SANITATION

THE INSPECTOR OF NUISANCE
THE TEACHER OF SANITATION
THE SPRING CLEANER
THE SCAVENGER
THE SEXTON

CHAPTER XXVII

THE INSPECTOR OF NUISANCE

SANITARIANS are all disturbers. They make heaps of trouble, insisting on all kinds of changes that mean cost and inconvenience. And yet how beneficient they are! People don't like them always, even when they see plainly how much good they have done. But the boldest, the most shameless, the most detested sanitarian—for he is a sanitarian as will be shown in a subsequent article—is the common House Fly. There are really two of them. Two indeed! Millions rather. Quite true; but two species of the genus is what I mean. The Lesser House Fly, (*Fannia canicularis*) is not a young fly, as many suppose, but a distinct species. In aimless, zig-zag fashion it flies round and round the chandelier.

But about the House Fly proper (*Musca Domestica*) there is nothing aimless. I know nothing of any musk about it, but it is domestic

enough; and it is decisive in all its movements. It is a disturber of the peace, and asks nobody's leave when it enters a house. Uninvited it will join you at table, sampling your jam, walking over your bread and tasting your sugar. You are all the more indignant because quite uncertain where the wretch dined last.

No sanitary reformer could ever match the house fly in boldness and determination. Observing it on the jam you wave it away. Before you can turn round it is back again. You make another movement to frighten the intruder off; but with an impudent flirt of his tail, as it were, he is on the wing and, for a change, alights on the table near you. With the most careful calculation of distance and flight you bring your hand down savagely on the intruder, to discover that under your hand is—nothing. Are you surprised? Remember you watch this enemy with two eyes: he watches you with 8000; and with no end of air-bags inside him to aid the flight of his two beautiful wings; the said wings being regulated by as fine a set of muscles as you could imagine.

After dinner you lie down for your "forty winks," and just as you are comfortably dozing

off something tickles the end of your nose, or the bald place on the top of your head, and instantly you are wide awake. The disturber of the peace again! He has alighted on the back of a nearby chair, and is evidently laughing at you. "You thought I was going to bite you. Not a bit of it. I couldn't bite anybody if I tried: I have nothing to bite with," is how he jeers you. Quite true; for the house fly has only a sucking or suction proboscis; and a very beautiful contrivance it is, as seen with a microscope. You wonder how the rascal sucks dry sugar. Well, he first moistens it with saliva, and then sucking is quite easy—for him, but not over pleasant for you.

The motto: "Put yourself in the other fellow's place," applies even to insects. The truth is that the fly is hungry. Catholic in his tastes he is as ready to dine off a dunghill as off your table. Having been attracted to your house by certain delicious odours, more readily discernible to his olfactories than to yours, he deems it right to help himself; that in part is what he is here for.

When he comes to tickle the nose or the pate he is on the same errand, seeking to relieve

your skin of certain emanations—of which you may be unconscious, but of which he is well aware—as calculated to furnish grist to his digestive mill. Can it be that such inconvenient attentions are due to the fact that a more scientific cleansing of the cuticle is needed? Anyway if proper attention were paid to refuse in our neighbourhood the occupation of the fly would be gone, and he would largely disappear from the haunts of men.

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CHAPTER XXVIII

THE TEACHER OF SANITATION

THE House Fly is more detested to-day than ever, since the discovery was made that from birth to death it is infested internally and externally with disease germs. Covered with hairs, especially on the legs, it readily carries away germs of disease from the impurities it infests. It feeds often enough on garbage and filth and deposits its eggs in the most unsavoury place it can find. The inference is obvious.

Three flies were examined: one from a house, another from the open air, a third from a dust bin, and disease germs were found in large numbers on each. On the first were twenty-five colonies of bacteria; forty-six on the second; and one hundred and sixteen on the third.

Worse still, a fly regurgitates its food; brings it back and eats it over again. Not unfrequently the food is vomited and left behind,

as may be seen wherever flies abound. Another method of spreading disease.

The danger is greatly increased by the fly's power of flight. After visiting a dust bin in a fever neighbourhood a fly may betake itself to a house a thousand yards and even a mile away. There is no certainty where this bold visitor last fed.

Then think of its rate of multiplication. Depositing from one hundred to one hundred and fifty eggs, this may be repeated half a dozen times in a season. If the progeny of a fly, assuming no check, were pressed together, the space occupied by the end of a season would be about a quarter of a million cubic feet. In hot countries where the rate of multiplication is still greater, the power and majesty of Beelzebub, the Lord of Flies, may be imagined. Life is made a burden: you eat flies, drink flies, dream flies; and what with typhoid, tuberculosis, dysentery and ophthalmia, you are likely to die of flies.

And yet is that all? Is there not another item on the other side before we strike the final balance? The fly may be said to exist for two main purposes. The first is the removal

of filth. Think for a moment what immense quantities of filth are removed or rendered comparatively innocuous by even a fraction of that 5,598,720,000,000 which it is calculated would be the progeny of a female fly, unhindered through a season. Whether does the fly do more harm or good in this way? A difficult question.

But the House Fly has yet another function to perform, that of calling our attention to the presence in the neighbourhood of our dwellings of quantities of rotten and decaying matter. The cure of the fly-evil is neither in fly-papers nor any futile Kill-that-Fly League, but in the careful removal of all such decaying matter as will furnish food and breeding ground for flies.

To remove the fly—if that were possible—and to retain the filth, would mean the unchecked multiplication of germs of disease and deadly bacteria. If the fly has caused some disease by carrying germs about, inadvertently, he has possibly prevented more by the destruction of germs.

Then is not the fly a creator of beauty, and that out of what is foul and disgusting. From a

footless, headless, light-shunning maggot, living, moving and having its being in the worst of filth, is developed a vivacious, sun-loving, aerial insect—a thing of beauty, if not a joy forever. May it count for righteousness that out of ugliness has been brought beauty, and out of foulness an inimitable grace?

Finally here is a great teacher of sanitation. Such incessant and unwearied labours indicate a direction in which man has largely failed. Once our streets, like those of an Eastern city still, were littered with filth and garbage. That has been remedied. But much remains to be done in the way of cleansing our whole environment. We must learn the lesson the House Fly seeks to teach us, or allow it to continue the transformation of what Dr Johnson described as, "matter in the wrong place," into objects of grace and beauty. The fly is the Divine judgment on the foul and the rotting, and the executioner is never a popular figure. May I claim for my client at least the Scottish verdict of "Not proven."

CHAPTER XXIX

THE SPRING CLEANER

NOBODY likes spring cleaning. The devices to mitigate its miseries are always popular; but whether an invasion of insect spring cleaners, however temporary, would be universally welcomed, is more than doubtful. It might be of very little use objecting. When the Driver Ants of Africa, or the Legionary Ants of South America take it into their heads to do somebody's spring cleaning, they do not ask leave. An army of them will simply march into your house and begin operations.

The Driver Ant is so named because it drives everything before it. All other insects, and many animals, will flee on the approach of an army of this terrible ant. And they do march in armies. They will march sometimes twelve or fourteen abreast, margined on each side, by a line of grenadier-sized guards, each facing outwards with uplifted mandibles (jaws) or patrolling about on

the flanks. Stragglers, or scouts, wander on each side of the column and seize on any kind of prey, "from a minute beetle to a cow."

Any difficulty in mastering the prey will quickly bring other ants to help. To get in the line of march is risky. The ants will swarm all over you, and then—well, you can guess. A lady missionary told me that when this occurs the ants do not bite till the captain gives them orders, and then they all bite together. This statement must not be taken as absolutely reliable. Presumably the lady did not try the experiment twice, so the first simultaneous bites may have been by accident.

The spring cleaners on entering a house, which may quite as well occur by night as by day, come in search of any insects or vermin that may have domiciled themselves there. The invaders swarm over everything—ceilings, furniture, boxes, drawers. Everywhere a moving mass of ants, on shelving, chests of drawers, bookcases! The sound of the feet of this countless multitude is distinctly audible. Insects will drop from the ceiling with several ants clinging to them. Plant-bugs, green and brown, on being assailed give forth their characteristic odour, filling the place with an overpowering

stench. Rats and mice will scurry forth in a vain attempt to escape their assailants.

And what meanwhile are the owners of the house doing? They have but one course open to them, and that is to turn out and leave the spring cleaners a free hand with the job they have undertaken. Hens and chickens have a poor chance under such circumstances. There will be nothing left but feathers and bones after the raiders have departed. When the work of clearing the premises of all kinds of vermin has been completed the ants will take their departure. Then, and not till then, may the owners return.

The Driver Ants found chiefly in Africa are carnivorous, and their marching armies go in quest of food. With their immense numbers they soon exhaust any local food supply, and constant migration is a necessity. Their favourite food is the Termites, or White Ants—so called, although not ants—and thus the balance is maintained. Strangely enough all the workers, composing these vast armies, are blind. The males which are numerous, have eyes, and so have the females, albeit the latter have rarely been seen.

CHAPTER XXX

THE SCAVENGER

ONCE upon a time our streets were left to clean themselves. The period is sometimes referred to as the good old times. To-day the scavenger is an important member of the community, on whom the public health largely depends. To what an extent this is so will become evident to any visitor to an Eastern city, with its foul streets and evil smells. There Nature cannot carry out her work for many reasons, but away from inhabited areas she has an army of efficient scavengers. Most of them we regard as loathsome; but we could not do without their beneficent activities. They serve in Nature's great regenerating factory, melting down and renovating matter which otherwise would make the continuance of life impossible.

The Flesh Fly and the Bluebottle are only too familiar to the housewife. She detests

them, and little recks that they are essential to the life of the race.

To say that the Bluebottle is vigilant is very tamely to state the facts. Not a sparrow falls to the ground without her knowledge. Scarcely have the bright eyes glazed ere news of the happening is wafted abroad among the great army of putrefactory chemists in the neighbourhood.

It is not improbable that the ant may be on the scene first, even though it be only a big fat caterpillar that has somehow missed its final stage of evolution; but she is intent only on the food thus provided.

The Bluebottle will next put in an appearance. Alighting by preference on the bird's head, she will discover a tiny opening at the junction of the beak, and here she will insert her ovipositor, which like a telescope, can be lengthened or shortened at will. For a couple of hours, with intervals for rest and for the polishing of her laying-tool, she will keep her ovipositor active, with the result that at the root of the tongue and the entrance of the throat and the membrane of the palate, the surface will be covered with a continuous layer of eggs.

In two days the eggs will hatch, and the whole of the squirming mass will disappear down the throat. Sometimes the deposit may be made in the socket of the eye, or in the wound which will be found with unerring skill beneath the feathers, or in a cavity of the axilla (with us, armpit) where the skin is sufficiently delicate.

The reason why some easily accessible part is chosen is because the maggot has no means of penetrating any tough object. It can penetrate soft meat, but no solid particle is detached and swallowed. Without a sort of liquid extract of meat it must perish; but Nature has gifted it with the means of reducing solid meat to broth. Upon the food is poured a far more powerful solvent than anything of the kind known to science.

Pepsin, as Fabre conclusively proved, is simply not in it. This solvent rapidly reduces the solid meat to a liquid. But powerful as it is, it is not capable of acting upon a skin of a tough, horny nature. Hence the care of the mother in placing the eggs only where the grubs will find the meat they require.

If, as has been asserted by Linné (quoted

by Kirby and Spence), three flesh flies will devour a horse as quickly as a lion would do, the eggs of the Bluebottle will be little less effective for the purpose. They will reduce the whole to liquid, and what they do not absorb will easily find its way into the soil to fructify and enrich it. Thus does life deal with death and transform it into a minister of life. Fabre calculated the number of eggs a Bluebottle may deposit at 900. But a Flesh Fly may deposit 20,000, not eggs, but grubs alive and ready to begin work.

One evening I found the remains of a Red Deer in the woods. How it had died there was nothing to show. Only a few bones and a quantity of hair remained. Yet even so the scavengers had not completed their work. The maggots were still busy disposing of the last remnants of matter, so that the woods might retain their sweetness and the earth be fertilised by the tragedy which had been enacted. Otherwise the whole neighbourhood would have been tainted and intolerable.

CHAPTER XXXI

THE SEXTON

THE pioneer sexton was the Beetle, the most numerous, and in some ways the most important, of all the scavengers to which we are indebted. Their work is largely unseen, but vital to the welfare of mankind. Their number is legion, as it needs to be, considering the enormous amount of work they have to get through.

Of the three hundred thousand known species of insects, about a hundred and thirty thousand are beetles, and they outnumber all the rest. Some of them we find extremely repulsive—the cockroach for example, which however is not a beetle at all—others we look upon as specially beautiful. Apart altogether from the beauty discernible in the structure,—where can you find such gorgeous colours of green and golden-green, of purple and violet, and yellow and orange-yellow, of scarlet and amethyst, and I know not what colours and shades besides, as among the

beetles? All beetles are not arrayed in the sombre hues of the undertaker; it is not a burying but a feast to which many of them swarm, and they are not unsuitably arrayed for the merrymaking.

Even the chief of the clan of burying-beetles —the Necrophorus—is quite gay in appearance, with his antennæ, red-tufted at their tips, his nankeen-covered breast, as Fabre describes, and the double-scalloped scarf of vermilion across his wing cases, with a suggestion of the guardsman. Standing at the head of an important order of sextons, he is distinguished in his costume and lugubrious in his air. If somewhat gay in his attire he is anything but gay in his manner: for his is a serious business, and he goes about it deliberately.

Built for his job, his orange-banded coat is of workman-like shape. His shovel-like head will serve both as shovel and ploughshare. He has immense shears; and his great hairy arms and legs are navvy-like both in their form and proportions. If he does not spit on his hands when about to wield his picks and shovels, he spits all the same, like most of his species. Considering his occupation we must not be too

exacting; humans similarly engaged might do the same in spite of any number of requests to refrain from so objectionable and dangerous a practice.

It must be admitted by the most fastidious that Necrophorus is strictly business-like in all his methods. Wherever his services are required he will put in an appearance on the shortest notice. So prompt indeed is he that you might conclude he had been summoned by wireless—as in fact he has been—and that he travelled by aeroplane. But though a trifle clumsy in his gyrations in the air, he gets there —and that is more than can be said of many aeroplanes.

If it is astonishing how these other Nature scavengers, the vultures, become aware of the carrion—immediately seeing or scenting it from incredible distances—our insect scavengers are capable of still more surprising feats in the same line. From the head of the order down to the humblest servitor, they throng almost instantly to the scene of the varied duties to which they are ordained.

No eagle has ever more instant knowledge of the carcass than these transcendent alchemists

and consummately clever grave-diggers of the grasshopper, the lizard, the mouse, the bird or rat or mole, demanding their services. And our worthy sexton is not in the least exclusive. All is grist, in the way of putrescence, that comes to his mill. He samples it, surveys its situation with a keen eye for soils and sub-soils, and, if no obstacle prevents, forthwith goes underground.

Assuming that the deceased has fallen on good ground, sandy or loose, a couple of sextons will make their appearance, or more if there are many unemployed in the neighbourhood. A furrow or ditch will be ploughed right round the carcass—the huge head an excellent tool for the purpose. A second and third furrow will be made, the last one being carried right under the body, beneath which the workers now disappear. Then a curious thing happens: the corpse begins to move as if coming to life; from time to time strange tremors run through it, and it will presently oscillate.

The ordinary observer will not be able to see how this is done; but Fabre, by various experiments, was able to discover the sexton's methods. The beetle, turning over, grips the hair or feathers

of the dead animal with his six claws, props himself upon his back and pushes, using forehead and stern as a lever. His immediate purpose accomplished, he resumes his normal position and digs. Gradually the grave enlarges, and the body is dragged down into it.

Occasionally a male sexton will come out and walk round the body, exploring, probing, and then disappearing to resume his digging or shaking. Gradually a high furrow of sand or soil grows up all round the body, which sinks into the space prepared for it, partly by force of gravity, and partly by being shaken and pulled down by the undermining beetles. As this work proceeds the grave fills itself. The soil slips into place from the outer circle and covers the body. Various difficulties sometimes present themselves. Fabre explains how these are overcome.

As to the reason of all this incredible labour. It is the perpetuation of species. Fur or feathers will be stripped from the body and eggs deposited. These in a few days will be hatched, and in a fortnight the larvæ will have completed the metamorphosis of much of the dead body in their own wonderful structure, and the

soil will do the rest in transforming a horrible putrescence into what may once more become the minister of life. The matured larvæ, white, naked, blind, will now dive into the soil, there to undergo the final transformation.

IN PARASITISM

THE SLAVE HOLDER

THE POPULATION CONTROLLER

CHAPTER XXXII

THE SLAVE HOLDER

It seems incredible and yet there is slavery among these ideal Republicans and model people, the ants. In a Republic revealing the very perfection of social organisation, where each is for all and all for each; an elect people with no quarrelling, no jealousy, no strife, where if anywhere liberty, equality, fraternity might be expected to obtain: and yet slavery exists, naked and unashamed. Where we might have counted on perfection, the "sum of all human villanies," slavery and slave-raids, are to be found.

The facts are beyond dispute. An observer, as long ago as Huber, has attested the results of his own personal experience. This testimony is confirmed by Lord Avebury and others. An army of red ants (*Polyergus rufescens*) is seen on the march. On the flanks of the column, as if to dress its ranks, a few ants speed to

and fro in eager haste. A quarter of an hour's march brings them to an ant-hill of the small black ant. The red ants make an attack in force, overpower the guards at the gate, and swarm into the citadel. Inside there is desperate combat, but the black ants are overpowered, and presently the invaders emerge, each carrying a young ant in the larva or pupa stage. Evidently the raid was for the purpose of capturing children. Back to their own city the raiders hurried, and were welcomed as victors.

A much more elaborate account is quoted from Huber in the pages of the most recent work on ants.[1] Several pages are devoted to the subject. On one occasion a small division of Sanguine Ants was despatched from the garrison, and arrived in quick march near a nest of Negro Ants, situated twenty paces distant, around which they took their station. The inhabitants, on perceiving these strangers, rushed forth in a body to attack them, and led back several prisoners. The Sanguine Ants made no further advance; they appeared to be waiting some reinforcement.

[1] *Go to the Ant*, by Edward Step, Hutchinson & Co., 18s. net.

From time to time little companies arrived from the garrison to strengthen the brigade. They now advanced a little nearer, and seemed more willing to run the risk of a general engagement; but in proportion as they approached the negro dwelling, the more solicitous did they seem to despatch couriers to the garrison, who, arriving in great haste, produced considerable alarm, when another division was immediately appointed to reinforce the army. With this reinforcement the besiegers still delayed attack.

Meanwhile the Negro Ants massed themselves in front of their nest, their army occupying an area of about two feet square, and there awaited the onset of the invaders. In the frequent skirmishes which took place all around the camp it was the besieged who always attacked the besiegers.

Though seeming to be determined on a vigorous resistance the Negro Ants betrayed some nervousness, as they began to take steps for the protection of the young, one of the most extraordinary evidences of prudence of which the history of insects can furnish an example. The pupæ are brought out of the nest and heaped up on the side opposite to the invading army, in

order to carry them off with greater readiness should the battle go against them.

And now sufficiently reinforced the Sanguine Ants begin an attack on all points and reach the very gate of the city. After a determined resistance the besieged give way and retreat to the rear, seizing the pupæ with a view to carrying them to a place of safety.

Soon the whole body of Negro Ants are in flight, pursued by the enemy who seek to capture the treasure; some few fight their way through the ranks of the defenders into their city and expeditiously carry off larvæ.

The invaders now enter the city and set about securing any larva remaining. This is removed to their own city, an uninterrupted chain being established from one ant-hill to the other. Next day the pillage is completed; but deeming the captured city better than their own the conquerors transfer all their possessions to it and make it their abode.

So far we have witnessed only a conquest with the spoil to the victors. It is in what comes afterwards that slavery occurs. The captured baby ants awoke to conscious life in a state of slavery. They grew up never having known

anything else. They were set to the work of the nest without apparently having any idea that their condition was other than right and proper. Born in slavery, they lived and died in slavery.

This was bad for them but worse for their masters, or perhaps more correctly, mistresses. Having everything done for them, even to being fed, they become indolent, and after a time, incapable of feeding themselves. With food all around them they would perish miserably, in the absence of their slaves. Slavery, here as everywhere, degrades both slave and slave-holder.

CHAPTER XXXIII

THE POPULATION CONTROLLER

In Nature there is a principle of check and balance without which life would quickly disappear from the globe. A familiar example in the animal world is the snowshoe rabbits of north-western America. After multiplying with amazing rapidity for some years they will be almost destroyed by an epidemic.

Similarly in Australia there is a plague of mice every few years, when so numerous are the little rodents that to go into the yard after dark is to tread on them. Then comes an epidemic, and in a few weeks they will nearly all disappear. The same law obtains in the insect world. If the aphis or greenfly were allowed to multiply without check to the tenth generation the progeny would number 100,000,000,000,000,000,000,000,000,000. Huxley calculated that 10,000 aphides would weigh one grain avordupois, and that by the tenth genera-

tion, if unhindered, the weight would equal that of one million billions of men, each of twenty stones. Of course they are not unhindered, but have a host of enemies bent on their destruction. But it is the example furnished by the caterpillar family with which we are just now concerned.

I shall never forget the surprise, the horror, the anger, I experienced one day in boyhood when I saw for the first time an illustration of the law of Balance, though I did not then recognise it as such. For some weeks I had been rearing caterpillars in a box, feeding them with cabbage leaves. I had noted how they changed their skins, periodically, sloughing off the old ones; and the first chrysalis that was formed filled me with wonder and delight.

Then one morning I found a caterpillar a squirming mass of maggots, which after feeding on the poor caterpillar's body had eaten their way out. I believe in my wrath I killed the whole wriggling mass. But the next time the same tragedy occurred, for some reason, the maggots were felt alone, and in a few hours I found, to my surprise, that they had spun for themselves pretty little yellow cocoons.

I was curious to see what came of these small

chrysalides. From them came presently, tiny flies with slender wasp-like waists, or pedicels. These I discovered were ichneumon flies. It was believed then that they deposited their eggs in the backs of the caterpillars, and the eggs hatching into maggots or larvæ, fed on the body of the victim, only emerging when full grown and ready to pupate. But by a number of careful experiments the famous French naturalist, Jean Henri Fabre, discovered that this particular ichneumon fly does not deposit its eggs in the caterpillar at all, but in the eggs of the caterpillar before hatching. So that these caterpillars are doomed before they are born.

Then Fabre, who took nothing for granted, exposed another ancient fallacy. It had always been supposed that the maggots devoured the body of their host. But they are incapable of devouring anything, as Fabre discovered. Their mouths are a mere sucking apparatus, incapable of dealing with anything except liquid. What the larvæ live on is the caterpillar's blood, and what is left behind is a mere shell, drained of its life fluid. Nor do they make their way through the back where the skin is compara-

tively thick—for they have no teeth—but at the sides or under-surface at the junction of two segments where is a point of minor resistance. Even there, only one opening is made through which the whole swarm makes its way.

And what of the caterpillar? It did try to weave the silken carpet to which the chrysalis is attached, but soon gave it up and died. The same thing happened in other similar cases. No beautiful house, no resurrection in the form of a gay butterfly the following spring. A poor, helpless, shrivelled thing lay motionless for a few hours and then an end.

The ichneumon fly then is one of the agents preventing the over-multiplication of caterpillars, and it, in turn, has its enemies, which prevent its becoming too numerous. So the principle of Balance operates all through Nature.

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